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MACHINERY OF GOVERNMENT

SEVERAL distinct trends in public affairs have directed fresh attention in recent months to the adequacy or otherwise of the existing instruments of government in meeting the post-war needs of Britain. The reorganisation of the defence ministries under a co-ordinating Minister of Defence and the tendency to enlarge the responsibilities of the Lord President of the Council for the oversight and co-ordination of scientific effort, making him in effect the Minister for Research and Intelligence suggested by the Haldane Committee of many years ago, have raised the question of the efficiency at the highest level of administrative organisation. The formation of the Defence Research Policy Committee and the Advisory Council on Scientific Policy, with their various sub-committees, is only one special aspect of the problem of relating knowledge to power at the very seat of authority. Sir Stafford Cripps' appointment as Minister for Economic Affairs was another indication of re-organisation in accordance with the recommendations of the Haldane Committee. The Government's programme of nationalization and the creation of the National Coal Board and similar national boards have also brought into question both the capacity of the Civil Service itself and the existing structure of government to deal competently and efficiently with the issues involved, while proposals for the re-organisation of local government and regionalism have likewise stimulated thought on these matters.

It will be recalled that in its fifth report of the 1946–47 session, the Select Committee on Estimates concluded that insufficient thought had been given to adapting the machinery of government to its new tasks, and referred to the danger that in spite of the formation of new ministries and the placing of much of the responsibility for the conduct of nationalized industries and like activities in the hands of quasi-governmental boards, certain Departments of State might have become too large and cumbrous to work as rapidly and efficiently as single administrative units. A reconsideration of the whole pattern of government in the light of modern conditions might well suggest a re-organisation that would increase the rapidity and efficiency with which the ever-growing volume of work is discharged. Even if this survey led to no reduction in staff, it should at least obviate further increases.

It has been objected that such a committee as that suggested by the Select Committee, consisting of a few highly placed and experienced persons from outside the Civil Service, would be less likely to yield practical results than a committee of permanent heads of Departments. Whatever substance there may be in that criticism, there can be no doubt that there are the gravest objections, as has been again pointed out by Dr. W. A. Robson in his able article on the machinery of government in the recent issue of the *Political Quarterly*, to the secret proceedings of the Cabinet committee on the machinery of government. The whole question demands public discussion, and it is well to note that besides Dr. Robson's article, this

specific question is discussed by Mr. D. N. Chester in an article "The Efficiency of the Central Government" in the *Journal of Public Administration*, and is the subject of a discerning chapter in Mr. H. R. G. Greaves' recent book, "The Civil Service in the Changing State"*.

Dr. W. A. Robson reviews with approval the arrangements for co-ordinating the Service Ministries and defence policy under the Minister of Defence; but he points out that a ministerial hierarchy is already emerging, and that the effect of the concentration of power in the hands of five or six ministers calls for reflexion. He sees, it is true, in the creation of a Minister of Defence and a Minister for Economic Affairs a trend towards the recommendations of the Haldane Committee; but the growth of functionalism has already made the Home Office anomalous, while the Colonial Office and the Scottish Office are in part, at least, territorial concepts. Dr. W. A. Robson lends his own authority to the suggestion that the whole question demands impartial and objective examination by a committee possessing exceptional ability, great experience of public affairs, disinterestedness and freedom from ministerial preoccupations.

Dr. Chester's article is less concerned with the fundamental structure of the machinery of government than with its operation and the factors responsible for overloading it, and for the decline in the capacity of departments which it is believed has occurred in the last two or three years. None the less, the factors to which he directs attention only strengthen the argument for the early and authoritative review urged by Dr. Robson. It is true that little can be done immediately to counteract the detrimental effects of the demand of the war years on the health of most senior officers; but one certain result of the review of the structure of government at the highest level would be to relieve the tremendous strain which the present plethora of international and like conferences places on senior officials.

Time alone can rectify the defects due to the abnormal turnover among permanent secretaries in the Civil Service which has marked the last few years; but something could be done to redress the weaknesses resulting from the return to civil life of many of the more distinguished temporary members of the Service. On the other hand, there are certain factors which at present favour the central administration, and Mr. Chester does well to point out that they are temporary. The diminishing respect for law which is so marked a characteristic of the post-war years cannot be expected to leave the process and execution of administration untouched. The British people have been accustomed to administer themselves, and a central administration which forgets that fact and does not seek to enlist the support and understanding of the governed is inviting trouble through the breeding of lawlessness.

Mr. Chester, like the Select Committee on Estimates, points clearly enough in general terms to some of the needs and dangers of the present situation. Overloading the administration almost inevitably means that there is no shedding of work which is not essential so as to concentrate on the big national issues. It means, too, that no attention is given to the use of devices to facilitate the execution of policy without employing large numbers of officials, and it is equally unlikely that effective use will be made of outside ability and experience.

These are all urgent needs if the Civil Service is to cope efficiently with the tasks that are now being laid upon it; but they are unlikely to be met unless at the highest level the structure is such that excessive strain is removed and those concerned with the formulation of policy are alive to what is administratively possible rather than politically desirable from the party point of view. The first task must indeed be to take the examination of this whole question right out of the arena of party politics and examine it scientifically and objectively, as it was examined by President Roosevelt's Committee on Administrative Management.

Mr. Greaves' analysis of Treasury control in relation to the machinery of government is no mean contribution to the understanding of the whole subject. In particular, a very fair appreciation of the way in which the Treasury has already adapted itself to the better co-ordination of policy relating to Civil Service matters indicates a series of further administrative needs, arising in part out of the Treasury's financial responsibility and in part out of its general co-ordinating function as the department of the Prime Minister. There are doubts as to whether the Treasury is sufficiently intimate enough with the work of other Departments to fulfil such co-ordinating functions, particularly the periodic review of departmental organisation. There are also doubts whether the Treasury has equipped itself for dealing with the new and different problems in the field of social services, and of the economic and industrial undertakings for which the State has developed varying degrees of responsibility.

Mr. Greaves brings out very clearly that provision is required for co-ordination at two levels. The first is at the ministerial level, where the task normally belongs to the Cabinet and where further delegation of more onerous parts of its work may be necessary on lines indicated by the appointment of a Minister of Defence. The second level is that of secretariat, and here Mr. Greaves stresses the necessity for something in the nature of a super-departmental staff to advise the Prime Minister in particular and the Cabinet as a whole.

An authoritative body to create and maintain the machinery of government—a directive authority for the scientific ordering of public administration in the larger and more complex connotation of that term in the modern social-service State—is considered by Mr. Greaves to be of high importance. He appears to visualize this as a permanent feature of the structure of government. Another need is for an agency of information and public relations, the function of which would be to organise and foster at every level of execution plans for the understanding and co-operation of the public—a need which has been consistently ignored by the present Government and repeatedly

* The Civil Service in the Changing State. By H. R. G. Greaves. Pp. 240. (London: George G. Harrap and Co., Ltd., 1947.) 10s. 6d. net.

stressed by constructive critics, notably in certain P.E.P. broadsheets.

The need for an informed public opinion is increasingly apparent, but it is not so widely appreciated that an informed public implies a conscious effort to inform it—a blend of the arts of publicity and education. Mr. Greaves does not make the mistake of imagining that attention to administrative needs, the provision of means for the periodic overhaul and review of the general lay-out of departments and the distribution of responsibility at the top will suffice. The scientific treatment of establishment matters, including recruitment, promotion, physical conditions of work over the whole field of public service, and research in the whole field of government are also necessary. Information must flow adequately upward as well as downward, and a new temper must be infused into the whole field so as to secure, at the highest level, clear thinking on administrative organisation, firm direction, fundamental reforms and strenuous and sustained endeavour. The segregation of the central official must be overcome, and the whole service brought into closer contact with the spirit and tendencies of the new society. Only when clear understanding of the issues is developed on both sides can we expect either the imaginative and bold reforms and experiments in administration to be initiated, or the public support and co-operation which are indispensable for the enactment of policies thus conceived.

That the danger of bureaucracy does exist as the public service becomes more efficient is made plain by Mr. Greaves; many others have done the same since the Haldane Committee directed attention to the point in emphasizing the necessity of real Parliamentary control being enforced so as to keep pace with any improvement in departmental methods. What must be stressed above all is that we have here a searching test of democracy, which makes high demands on the Government at all levels and also on the private citizen. Whether democracy can meet that test has yet to be seen, but the issues are at least made plain. The Haldane Committee was fully aware in making its suggestions that an efficient departmental system working in satisfactory relation with Parliament could not be established or maintained on lines laid down in advance by any committee of inquiry. The practical efficacy of the principles which the Haldane Committee suggested depends upon the zeal and discretion with which they are applied from day to day by Parliament, by Ministers and by the officers of Departments.

These are the living forces whose spirit is essential to any form of government that is more than a machine; and while we may yet have to evolve, as a result of further experiment, the forms of organisation and the rearrangement of duties which will best serve the needs of the social-service State and preserve the values of democracy, there can be no question that the forces have sometimes been ignored by the Government to an extent dangerous to the existence of a free society. Parliament as ultimate authority must, as Sir John Anderson said in his Romanes Lecture, have adequate opportunity for inquiry, for debate, and for passing judgment. To curtail that opportunity, in order to serve the dictates of a party legislative programme, is as fatal to democracy as the totalitarian treatment of human beings as though they were inanimate objects. There may be no science of statesmanship or politics or persuasion, as Prof. A. D. Ritchie holds. But the study of government and administration holds both promise and profit; and not the least for the growing emphasis on, and understanding of, the human factor both among those who govern and who are governed, which marks these attempts to analyse the problem to-day and to present some approach to a solution.

TREES IN PROSE AND PICTURE

Handbook of the Trees of the Northern States and Canada, East of the Rocky Mountains

By Romeyn Beck Hough. Pp. x+470. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 28*s*. net.

Trees for Town and Country

A Selection of Sixty Trees suitable for General Cultivation in England. Prepared for the Association for Planning and Regional Construction by Brenda Colvin and Jaqueline Tyrwhitt; with drawings by S. R. Badmin. Pp. 132. (London: Percy Lund, Humphries and Co., Ltd., 1947.) 25*s*. net.

INTEREST in trees has increased with the augmented interest in gardening, while the recognition of the merits of roadside planting and the amenity value of trees in the modern vast conurbations has developed the need for more information concerning the exotic species. Moreover, the shortage of timber supplies has involved the economic exploitation of a wider range of species for many purposes and thus stimulated interest in them from other aspects.

Mr. Hough's handbook of the trees of the northern United States and Canada is chiefly notable for the excellent illustrations and the thought devoted to their preparation. This work deals with twenty-three species of coniferous trees and one hundred and eighty-five broad-leaved species. Each of these is illustrated by means of photographic reproductions of the foliage and fruits, the winter condition of the twigs and the appearance of the trunks. For most of the species distribution maps are also provided, and in many instances a photomicrograph of a transverse section of the timber. The use of a background grid for the details and of a rule in all the photographs of trunks enables the reader to assess the scale of reduction. In view of the excellence of the illustrations it seems almost ungracious to cavil at the omission of photographs of the flowers, and the difficulty of recognizing the limits of the foot-rule in front of not a few of the tree trunks.

The book should have a wide appeal, and not least in Great Britain, where American trees have been so long cultivated and prized. To the student the descriptive matter contains much of value and interest; and a perusal of the distribution maps will recall many noteworthy features, as, for example, the large proportion—some 72 per cent—of arboreal species more or less restricted to the eastern half of North America, and the small proportion which are

restricted to the western half, while a few afford examples of discontinuity, particularly the swamp species *Leitneria floridana* found as a native tree in Florida and again from Missouri to Texas. The few species confined to the western States comprise two conifers and two poplars.

Keys are provided to the genera and species, although as these depend in large part on reproductive characters their usefulness is limited. The text and illustrations of this work together constitute a valuable and convenient source of information that will be of service alike to the botanist, the arboriculturist and the forester.

"Trees for Town and Country" is a book of a more utilitarian character in which the emphasis is naturally placed upon growth and habit rather than on details of morphology. Each of the sixty species selected is illustrated by a full-page photograph. Many of these are excellent both as typifying the species portrayed and as tree portraits; but a few scarcely do justice to their subjects, as, for example, those of *Catalpa speciosa*, *Prunus avium* and *Carpinus betulus*, and, particularly with respect to the last-named, fail to convey their potentialities. The hornbeam is a really superb tree when allowed to develop properly, although this is too little realized because its tolerance of trimming and pollarding has so often destroyed its intrinsic merits both in winter and summer.

Each photograph is accompanied by line drawings by S. R. Badmin which are both useful and charming, representing, as they do, the details of structure, the winter appearance and the average heights of the species at various ages, so that the prospective planter can judge the space required and the probable effect on the landscape. The figures are accompanied by short notes on soil, climate, growth and cultural details.

For the tyre especially, this work should prove a very real aid in assessing the merits of the more familiar subjects; though it must be borne in mind that such selections as this suffer from the defects of their merits and may, unless used with caution, lead to stereotyped planting and failure to utilize species such as, for example, *Prunus padus*, *Tilia parvifolia*, *Tilia petiolaris*, and *Sorbus torminalis*, which though not included here, may, in certain circumstances, have a prior claim to consideration.

E. J. SALISBURY

BRAIN AND MIND

The Physical Background of Perception

By E. D. Adrian. (Being the Waynflete Lectures delivered in the College of St. Mary Magdalen, Oxford, in Hilary Term 1946.) Pp. viii+95. (Oxford: Clarendon Press; London: Oxford University Press, 1947.) 10*s*. net.

PHYSIOLOGY has been defined as the outcome of a curiosity about ourselves. Such curiosity reaches its peak in the attempt to discover what material events in the brain accompany, and might be responsible for, the conscious processes of feeling and thought. The brain–mind relation is the no-man's-land on which the theologian, the psychologist and the physiologist meet face to face. The problem is age-old, and no immediate solution is in sight. The physiological approach has, however, advanced somewhat in recent years. This has been chiefly due to the work of Prof. E. D. Adrian at Cambridge, who summarized the present position in his Waynflete Lectures at Magdalen College, Oxford, in 1946, which are now available.

Prof. Adrian starts from the point that what goes on in the brain is to a large extent determined by what comes into it from the sense organs. It is firmly established that only one type of nervous message, the standard nerve impulse, is transmitted in the nervous system. There is thus only one common form of signalling available, and the message signalled depends for its qualitative interpretation on where it has come from and where it arrives. The sense organs sensitive to one particular type of physical or chemical change are connected by their own private pathway to one particular part of the cerebral cortex, which constitutes the cortical area in which that particular sensation is perceived. Within each cortical area there is a spatial localization of the different parts of the peripheral sensory field. The cortex may thus be regarded as a sensitive screen on which is projected a map or replica of the external world as appreciated by the sense organs.

This cortical projection of sensory data is a concrete reality; it is a pattern of electrical activity which can be mapped out in considerable detail by physiological methods. The map has been fully studied in anæsthetized animals, and the main conclusions have been confirmed in man during surgical operations on the brain. There is no direct proof that the intensity and duration of a sensation are strictly related to the temporal pattern of nerve impulses arriving at the cortex, but the accumulation of much indirect evidence makes this highly probable. One important point, which Adrian's work has clearly brought out, is that the size of the cortical area allocated to a particular sensation coming from a particular part of the body is not determined by the size of the sensory field concerned but rather by the importance which that particular part of sensation has for the conscious behaviour response of the animal. Naturally this varies considerably in different species. In the pig, for example, the tactile area for the snout is quite disproportionately large as compared with that for the rest of the body and with other species. In man, the tactile area for the hand is much bigger than that for the foot.

The arrival of sensory impulses in the cortex can be studied in the anæsthetized animal; but the next stage, the inquiry into what happens in the brain after the impulses arrive, and the relation of this to mental processes, must be pursued in conscious man. Here the technical difficulty that electrical recording can, ordinarily, only be carried out through the thickness of the skull precludes any very exact localization. Nevertheless, one very important and unexpected discovery has been made. When the cortex is inactive, as during anæsthesia, in sleep or simply during inattention, there is a synchronous rhythmical activity of the cortical cells at a frequency of 7–10 impulses per second (α-rhythm). This rhythm originates in the parieto-occipital area, but extends over the greater part of the cortex. When conscious attention is given to what is seen, or when mental calculations are performed, the rhythm disappears or is replaced by a faster local rhythm. The transference of conscious attention to one particular area of the cortex appears to involve the setting free of that area from the basic α-rhythm so that it can be used by the 'mind'. The only prerequisite for the existence

of consciousness seems to be that some part of the cortex, and not necessarily a large part, should be freed from the α-rhythm and so made receptive to incoming sensory messages. The mechanism which suppresses the natural α-rhythm and so causes, or allows, consciousness, does not reside in the cortex itself; it appears to originate in the upper part of the brain stem and almost certainly involves the hypothalamus.

So far a mechanistic interpretation suffices; but when we inquire how the brain recognizes and remembers things, very serious difficulties arise. For example, we know that a tune is recognized whatever its key, and a shape is recognized whatever its size and whatever part of the retina its image falls on. So it is obviously not a precise stimulation of certain nerve cells which the cortex recognizes; it must be some abstract pattern or concept which the brain in some way distils from actual sensory data and stores in its memory. Similarly, on the motor side, once a complex skilled movement has been learnt, it can be carried out, though less perfectly, with quite different muscles. Recognition and habit formation cannot, therefore, be due to the facilitation of particular nerve pathways by repeated use. On the sensory side, there must be something which abstracts the significant elements of a pattern; and on the motor side, something which converts an abstract idea of movement into an actual movement.

It is just here that all mechanistic hypotheses seem to break down, and it is in this that the brain differs from all man-made contrivances such as gun predictors, mine detonators and calculating machines. These machines respond when a certain fixed pattern of stimulation reaches a certain threshold. The brain, on the other hand, responds to an abstract pattern and is not tied to a critical threshold of stimulation. Indeed, the property of adaptation, so characteristic of the nervous system, renders it singularly inefficient in the recognition of absolute intensities of stimulation; it can only be relied upon to compare one thing with another.

This is the fundamental problem which confronts those who seek to explain mental processes in physiological terms. Adrian himself can see no immediate prospect of its solution, but he directs attention to certain ideas of Lashley and of Craik which might afford an approach. He concludes that, as contemporary physiology is unable to give a satisfactory account of any kind of mental activity, there is, as yet, no risk of its incursion into the field of metaphysics.

O. A. Trowell

MEDICAL DISEASES IN HOT CLIMATES

Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas. (War Office)
Eighth edition. Pp. 396 (37 plates). (London: H.M. Stationery Office, 1946.) 7*s.* 6*d.* net.

As vast numbers of troops were engaged in campaigns in the Pacific, South-East Asia and the Middle East, it is not surprising that many advances in medical knowledge of tropical diseases were made during the last four vital years of the Second World War. Much of this new knowledge is included in the present publication.

The book comprises thirty-nine memoranda arranged in alphabetical order. New articles are included on nutritional diseases, infective hepatitis, tropical eosinophilia, leprosy and the sulphonamides.

The section on arthropod pests contains pertinent information on the various uses of *D.D.T.* in the control of both the wingless and winged pests. Its special value in the destruction of mosquito larvæ and adult anophelines, house flies and lice is emphasized. *D.D.T.*, however, was ineffective in preventing scrub typhus, and here dibutyl-phthalate applied to clothing proved the repellent of choice, as it afforded most effective protection against the larval mite vector.

An instructive account is given of infective hepatitis based on the 'Alamein Line' outbreak affecting 10,000 troops. This is followed by a consideration of arsenical and homologous serum jaundice—both of which resemble in many respects infective hepatitis. The view is accepted that both these conditions are caused by inoculation with blood or serum containing a virus or some allied icterogenic agent. The comprehensive account on cysticercosis is abridged from the classical work of MacArthur on this subject; it is now gratifying to read that the more recent follow-up of Dixon and Hargreaves shows the prognosis to be brighter than was at first supposed.

The view that secondary invading organisms play an important part in those chronic cases of amœbiasis which prove intractable to amœbicidal drugs is accepted; preliminary treatment with sulphonamides and penicillin is advocated in such circumstances.

As a result of field experience with bacillary dysentery, it is advised that all individuals developing diarrhœa should be immediately treated with sulphaguanidine. This procedure not only reduced hospitalization by preventing the development of clinical dysentery, but also eliminated carriers and cut short epidemics through destruction of dysentery bacilli in the stools.

In the chapter on malaria, some twenty-four out of thirty-six pages are devoted to treatment. Doubt is expressed whether intramuscular 'Mepacrine' can replace intravenous quinine in the urgent treatment of cerebral and algid malaria. The great value of 'Mepacrine' as a suppressive in a dosage of 0·1 gm. daily is emphasized, resulting, as it does, in the radical cure of malignant tertian malaria and the suppression of benign tertian infections. The statement is made that "its use in the 1939–1945 war gave us great tactical advantages against the Japanese—we could operate in malarious areas which they had to avoid". While the first part of this statement is undoubtedly correct, it is doubtful if the Japanese ever considered the military implications of malaria or of any other disease in their forward planning.

A valuable addition to future editions would be the inclusion of graphs based on statistical data showing the dramatic reduction in the incidence of diseases like malaria, bacillary dysentery and scrub typhus following the introduction of preventive measures and chemotherapeutic control during the later phases of the Pacific and Burma campaigns.

As stated in the preface, the aim of this book is to give medical officers something that can be more easily carried about than a text-book and yet offer in a concise form the essentials of the more important diseases of the tropics. This objective has been splendidly achieved in the eighth edition.

N. Hamilton Fairley

THE THERMIONIC CATHODE

Les cathodes chaudes

Théorie et pratique. Par Charles Biguenet. Pp. 183. (Paris: Éditions de la *Revue d'Optique théorique et instrumentale*, 1947.)

AMONG many recent books under the general heading of electronics, there has been until now no comprehensive account of the basis of the subject, the thermionic cathode. While it would not be true to say that the well-known books by Reimann, T. J. Jones or de Boer are out of date, there have been developments in the past ten years with which both the student and the technician should be familiar; none of these books was intended to appeal to the valve designer or to deal with the technique of preparing thermionic cathodes and persuading them to liberate electrons according to the mathematical formulæ. For these reasons any modern account of the theory and practice of such cathodes is to be welcomed.

In the present book there is a detailed account of those properties of tungsten relevant to its use as a thermionic cathode, which will be of considerable value to the technical reader, while the section on thoriated tungsten is almost as comprehensive. There is a discussion of the process of carburizing, which is welcome as there is little literature on this subject, while the theory of the thoriated filament is adequately covered. The section on oxide cathodes is well written, with a modern approach, and summarizes the earlier information in the light of the present ideas of the behaviour of semi-conductors. The practice of the preparation and application of coatings is described, and also their treatment; while the author presents his own theory of oxide coatings and the difference between pulsed and continuous operation. This may justify discussion elsewhere. The remainder of the book gives a short account of other types of cathode, and of associated techniques such as high-vacuum technique, eddy-current heating and the application of the electron microscope.

One statement which is surprising is (p. 70) that hydrogen raises the work function and lowers the emission from tungsten. The original observation to this effect by Langmuir was found erroneous, as discussed, for example, by Reimann ("Thermionic Emission", p. 178). There are statements where it would be helpful if an authority were quoted or if the evidence were indicated; for example (p. 100), "if the degree of carburising of a thoriated filament is less than 6%, the filament remains sensitive to traces of gas", and (p. 129) "the normal operating temperature of an oxide cathode is from 850° to 900° C.". An important omission occurs in discussing the relation between temperature and current in a thoriated filament, where no reference is made to the importance of the geometry of the filament.

These are points of detail. A general comment is that the value of the book would have been increased if further practical information had been included, possibly at the expense of the adaptations from de Boer's book on adsorption. For example, there is little actual information about the pulsed operation of oxide cathodes, and none about the pulsed operation of thoriated filaments, or of their use with high-anode voltages. There is no discussion of gettering techniques and their relation to emission development and maintenance. There is, in fact, no indication that, in practice, difficulties are frequently encountered with cathodes of all types in obtaining or maintaining the theoretical performance. Thus we are not told whether thoriated filaments do in practice give the lives predicted by Langmuir's tables, while it may cause alarm and despondency among those concerned with valve manufacture and development to read that, after a prescribed treatment of an oxide cathode, "le tube est bon à couper et son émission électronique restera stable". The matter is not always so simple, especially with modern short-wave valves requiring high-current density.

D. A. WRIGHT

ICE CREAM

The Ice Cream Industry

By Grover Dean Turnbow, Prof. Paul Hubert Tracy and Lloyd Andrew Raffetto. Second edition. Pp. ix + 654. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 6 dollars.

IT is a commentary on the trend of life that a book of nearly 700 pages should be written on a comparatively small item of diet, an item which, until a few years ago, was either regarded as a luxury or as a special treat for small children. This one item has now become the basis of one of the big food industries, ice cream manufacture, and it must be admitted that ice cream is a useful and palatable method of inducing people to take more milk. Messrs. Turnbow, Tracy and Raffetto have in this revised edition brought their earlier work, of 1927, up to date; have added chapters and rewritten chapters, and the result is a very readable compendium of knowledge (there are a number of minor and several major errors particularly in the scientific parts) dealing with every aspect of ice cream, from manufacture to salesmanship. It would be an interesting study to try to decide which author has been responsible for the various sections, for they are not all of one style, and one gets the feeling of a vision of patchwork quilt.

From the point of view of the chemist, the scientific portions are interesting; but one might question the desirability of including in a book of this nature explanations of some of the underlying scientific principles of physical chemistry. It must be remembered, however, that in the United States there are courses at universities and at technical colleges dealing with the manufacture of ice cream, and the authors state that their review of the physico-chemical properties is for the advanced student. One cannot but feel that the elementary mathematics included in the section dealing with control and standardization is a strange bed-fellow for the physico-chemical theories.

In these days of austerity in Great Britain, it is refreshing to know that on the other side of the Atlantic such a wide range of delectable sweetmeats is still to be had—plain ice creams, fruit ice creams, nut ice creams, confection ice creams, bisque ice creams, ice puddings, parfaits, mousses, and so on, to mention but a selection. To-day, in Britain, there is a welcome interest in food-borne infections, and therefore the statements regarding this danger are of particular import. One could wish that the advice given in the chapter on "Washing and Sanitizing" (!) could be brought to the notice of all manufacturers and purveyors of ice cream in this country.

Having watched children and adults in Britain eating ice cream, the following (p. 385) from the

chapter dealing with the food value appears to the reviewer to be of great importance: "Too rapid eating or drinking of large quantities of ice-cold foods may be one of the factors responsible for some of the gastro-intestinal disturbances occurring during the summer months. Any discomfort from consuming ice-cold foods can be avoided by eating slowly, thus allowing the digestive system to function normally."

The survey of refrigerating practice is a concise summary of present practice and well worth study.

Everyone concerned with the production of ice cream may be advised to read this book.

L. H. LAMPITT

NORTH AMERICAN ARCHÆOLOGY

Indians before Columbus

Twenty Thousand Years of North American History Revealed by Archæology. By Paul S. Martin, George I. Quimby and Donald Collier. Pp. xxiii+582. (Chicago: University of Chicago Press; London: Cambridge University Press, 1947.) 33*s*. net.

THE authors of this book open their preface by saying that it has been written for the interested layman and for students taking introductory courses in anthropology, but that it is not intended as a general reference book for professional anthropologists. It can be said at once that it is a very useful work, though the greater part of it is likely to appeal more to the specialist, at any rate outside North America, than to the classes for whom it is intended.

The book is divided into eight parts, of which the first two are introductory, the third deals with the earliest American cultures, the next four describe the subsequent North American cultures under the headings of four great natural regions, and the eighth is a concluding summary with correlations. Part 1, entitled "Background", is frankly popular, but it includes a useful summary of how the New World was populated, and a brief, straightforward exposure of a number of hoary fallacies concerning the Indian. Part 2, on arts and industries, summarizes the methods of manufacture of various materials, and ends with a most useful account of what is known about trade and commerce in ancient North America. These chapters are admirably suited to the needs of the people for whom the book was designed; but more advanced students also will read them with pleasure, and very likely with profit, since they contain some new information. Few, for example, can have known that bannerstones and other unexplained objects of slate were really weights for spear-throwers. A valuable feature of Part 3 is the outline it gives of how early cultures, like the Cochise, led up to the better-known cultures of the south-west. There was no hiatus, only a very slow development, until the introduction of agriculture and pottery provided the stimulus to more rapid change.

The next four parts constitute the bulk of the book, and archæologists outside North America, who have had difficulty in following the numerous papers which have appeared within recent years and in forming a general picture from them, will find this the most useful section. The descriptions, competent though they are, will not of themselves be sufficient for this type of reader, but he will find what he needs to supplement them in the excellent lists of sources which accompany each chapter. On the other hand, elementary students and most interested laymen will require far more illustrations to lighten and give meaning to the closely condensed pages of facts. What illustrations there are might be rather more evenly distributed; many cultures have none, but, for example, the striking art of Key Marco in Florida has two whole pages. Each culture is described so far as possible according to a uniform plan, which facilitates reference, and in each case 'conjectures' are, by a wise provision, kept under a separate heading at the end.

The production of the book is excellent, the illustrations are good, and the main culture areas are clearly shown on a map occupying the end papers. The title deserves a word of criticism; North American archæology does not end with Columbus, and fortunately the contents of the book show that the authors do not really imagine that it does. Within the limits outlined above, it is a most valuable work.

G. H. S. BUSHNELL

ANIMAL PARADE

Parade of the Animal Kingdom

By Prof. Robert Hegner, assisted by Jane Z. Hegner. Pp. vii + 675. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 20*s*. net.

THE fact that this is the ninth reprint of a book first published in 1935 is sufficient evidence that it meets a widespread demand for a general natural history which will give in one volume some information about the modes of life and activities of various common animals. The authors have chosen representatives from each of the main phyla, arranged in order of their complexity from *Amœba* to man; but the basis of selection is somewhat original and one finds not only animals familiar in everyday life, or economically important for food, fur, etc., but also unusual animals, such as those commonly seen in circuses and zoological gardens, animals familiar in literature, prehistoric animals, and even the unicorn, werewolf, and other mythological animals.

As might be expected the greater part of the book, about two-thirds, is devoted to vertebrates, and half of the remainder to insects; but the examples are well chosen and a surprising amount of information about the remaining groups is given in short space. It should be emphasized, however, that the book is intended primarily for American readers and the complete absence of any scientific names sometimes introduces a certain ambiguity. Thus, harvest-men (Phalangids) are referred to as daddy longlegs, a term which in Great Britain is usually applied only to crane flies (Tipulids). The fur of the weasel is stated to turn white in winter, while in Britain the term weasel is reserved for *Mustela nivalis* the coat colour of which does not change in this way. In North America the term weasel seems to be synonymous with stoat or ermine.

There are 743 illustrations, but their reproduction leaves much to be desired; a certain number, including some of the Cœlenterates and Vermes, are obviously photographs of museum models; and a few are photographs of stuffed museum specimens, the gibbon being a particularly unfortunate example.

These are minor drawbacks, however, and the work can be recommended as a useful general natural history. The success of the earlier editions has made it possible for the present one to be sold at the price of twenty shillings.

EDWARD HINDLE

Synthetic Resin Chemistry

For Students. By Dr. S. R. W. Martin. Pp. vii+160. (London: Chapman and Hall, Ltd., 1947.) 15*s.* net.

DR. MARTIN'S book is best considered as an extremely practical guide to laboratory experiments for the student of synthetic resin chemistry, interspersed with an introductory survey of the theoretical side of this complicated field. The fifty-odd experiments are novel and well chosen; and it is difficult to know where else one could find details of such an illuminating series. They are simple, they are specific, and they work. On this score the book is wholly admirable.

Nevertheless, it is perhaps not unfair to doubt whether the accompanying theoretical matter, condensed and simplified though it is, will be smoothly absorbed by the type of reader visualized by the author in his preface—the student whose chemistry is of school certificate standard. This is no carping criticism; for the difficulty is one which must be faced squarely by anyone attempting to instruct the junior student in a technological subject with organic chemistry as its fundamental basis. True, the author devotes some twenty pages to a survey of elementary organic chemistry; but this alone is likely to prove heavy fare for the young chemist fresh from a school certificate course. It would appear essential to stipulate, not merely to hope for, "an elementary knowledge of organic chemistry" as a proper basis for the appreciation of the book. Taken, however, not on its own, but as an accompaniment (or, better, as a sequel) to a systematic elementary course in both aliphatic and aromatic chemistry, the book will be an invaluable guide to the embryo surface-coating technologist.

It may be hoped that in any subsequent edition the author will broaden slightly his title and terms of reference so as to include the cellulosic materials. As it stands, the book is useful only to the student in that section of the surface-coating industry dealing with phenoplastics, aminoplastics and alkyds: expanded slightly, its usefulness would extend to workers in all sections of the field.

P. D. RITCHIE

The Framework of Human Behaviour

By Dr. Julian Blackburn. (International Library of Sociology and Social Reconstruction.) Pp. viii+158. (London: Kegan Paul and Co., Ltd., 1947.) 12*s.* 6*d.* net.

THIS book, presenting in small compass an extraordinary mass of learning and research, the research of others being amply acknowledged, deals, as the title says, with the framework of human behaviour. That framework connotes the equipment with which any person is endowed before he begins his individual development in society. Part of this endowment is due to hereditary factors, and part to the kind of environment in which he has been born. In this book, by no means the author's first production on the subject, he considers the part played by heredity and environment in the physical and mental make-up of individuals, and the part played by sex and racial differences. He then goes on to discuss the behaviour of groups, national and social, and the influences by which they are motivated. The reader will need to know something of the modern psychologist's use of the word 'pattern'—definable as a complex whole, characterized by a definite arrangement or interrelation of parts; as a behaviour pattern or a pattern of brain activity. Many readers will find good use for the eighth chapter, entitled "Conclusion". The abounding references to other books are minutely careful. Dr. Blackburn has, in publishing this volume, made a substantial addition to the International Library of Sociology and Social Reconstruction.

What People Are

A Study of Normal Young Men. By Clark W. Heath, in collaboration with Lucien Brouha, Lewise W. Gregory, Carl C. Seltzer, Frederic L. Wells and William L. Woods. Pp. xvi+141+4 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1946.) 11*s.* 6*d.* net.

THIS book should be welcome if only because it deals with an unusual subject. In both Britain and the United States much time, energy and financial support have been given to investigations of the mentally and physically ill and handicapped; but little attention has been paid to well people, upon whom depend the leadership and work of the world. Yet knowledge of the normal is of great concern in medicine, education, business and government. This report is based chiefly upon the study of selected Harvard undergraduates, but groups of men in the armed forces and in civilian life have been investigated as well. Selection of college students was made on the basis of all-round good adjustment, good health and academic success. The approach is clinical. Characteristics of normal young men are described from the points of view of medicine, physiology, anthropology, mental measurements, socio-economics and psychiatry.

The authors make no pretence that this is a completed work, or that they have the answers to many important problems which they have presented. The field is a large one and much remains to be done.

One word more. We in Britain are bound to ask what about the normal young women, who are by no means content to leave all the leadership to the men, whether in medicine, education, business, or government?

Making Your Own Telescope

By Allyn J. Thompson. Pp. xi+211. (Cambridge, Mass.: Sky Publishing Corporation, 1947.) 3.50 dollars.

TELESCOPE making by amateurs has a great vogue in the United States. In association with the Hayden Planetarium in New York, there has, for almost a dozen years, been an Optical Division of the Amateur Astronomers Association. Facilities and space have been provided in the basement of the Planetarium for classes in telescope making. Mr. Thompson has for some years been the instructor of these classes and has had ample opportunity to develop and test efficient and practicable methods and to become familiar with the various pitfalls and difficulties that beset the beginner. In order to make available to a greater number of amateurs the experience that he has gained, this book has been written. It describes in some detail the methods of grinding, polishing, figuring and testing mirrors, as well as methods of correcting the more common defects, with many useful hints. The other parts of the telescope are not neglected, and descriptions are given of simple pipe mountings, the construction of which does not require much mechanical ability.

A brief account of the history and development of the telescope is given in the first chapter.

The frontispiece of the book is a picture of the author's 6-in. *f*/9 telescope, with equatorial head and tripod mounting; made in accordance with the instructions in this book, it is stated to have cost less than thirty dollars. It may be recalled that William Herschel first embarked upon telescope construction because he could not afford to buy one for himself. With the aid of this book, many a budding astronomer should be able to construct his own telescope at a moderate cost.

Aircraft Strength of Materials

By Dr. H. D. Conway. Pp. viii+256. (London: Chapman and Hall, Ltd., 1947.) 21*s*. net.

DR. CONWAY has produced a book that should be valuable to both students and designers dealing with aircraft structures, but its title is misleading. It is entirely a work on the theory of structures, its secondary connexion with aircraft being that those problems that are of most interest in that field have been chosen, and the illustrative examples are such as occur in the peculiar types of structure occurring in aircraft construction. A critic could quarrel with the author for his sins of omission rather than commission, but incompleteness is inevitable in a book of this size. Also the science of the design of aircraft structures is so fluid at present that a selection of methods is bound to be one based on the author's personal experience. This defect is most noticeable in the part devoted to the behaviour of thin plates, which might have been much fuller. Its application to Wagner beams and stressed skin construction can scarcely be avoided to-day in the aircraft world; even the engine designer is meeting it now in the internal combustion turbine.

The layout of the book is excellent and logical. The chapters follow in an ordered sequence, and are well illustrated with numerical examples, particularly useful to a beginner. The more recent methods of structural analysis, such as the Hardy Cross method, are fully explained. This alone puts the book in a class by itself so far as an aeronautical reader is concerned.

The author has the courage to say that he has not tried to avoid the use of mathematics, claiming that no serious aircraft designer could be without such knowledge, a statement with which the reviewer heartily agrees.

Electronic Theory and Chemical Reactions

An Elementary Treatment. By R. W. Stott. Second edition, revised. Pp. viii+112. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 6*s*. net.

THE development of electronic theories of the mechanism of reactions has reached a stage at which it is possible to give useful general accounts of the main features, and there are indications of a rapidly growing interest in the subject. This interest has now deeply penetrated not only the ranks of teachers of chemistry who have a regard for major theoretical developments, but also the harder core of chemists in industrial and other fields who attach greater importance to tangible applications and concrete results.

The publication of a second edition of Mr. Stott's elementary treatment will be greeted with pleasure by those who were unable to obtain a copy of the first issue. This edition is almost identical with the first (see *Nature*, **153**, 510; 1944); at a time when the prices of many commodities are rising steeply and continuously it is a pleasure to note that the old price is retained. E. D. HUGHES

Mechanical Vibrations

By Prof. J. P. Den Hartog. Third edition. Pp. xi+478. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 30*s*.

DEN HARTOG'S book combines mathematical simplicity with a rare insight into the physical nature of vibrations, and its author has a happy knack of explaining things in a way that the less gifted can understand. For these reasons, and for the wealth of information it contains, the book has long been a standard work in Great Britain as well as in the United States.

The present edition includes observations on helicopter rotors, the 'singing propeller' and oscillations of submarine periscopes. Electronic methods of vibration measurement and analysis, the damping of torsional oscillations in engine crank-shafts, oscillations excited by oil-film lubrication and 'flutter' are among important subjects which are discussed more fully in the light of recent work. This is a book of which no mechanical engineer should be unaware, and which those faced with vibration problems find of constant help. A. L. P.

Modern Assembly Processes

Their Development and Control. By J. L. Miller. Second edition revised. Pp. xii+199. (London: Chapman and Hall, Ltd., 1946.) 18*s*. net.

IN this new edition of his book, Mr. Miller has taken advantage of war-time experience to bring certain sections up to date; modern aircraft riveting practice in flush riveting and the invaluable pop riveting technique are described, for example. The descriptions of fluxes for soft soldering are considerably expanded and include recommendations for the lead/silver solders and the low-tin solders of B.S.219. Brief details are given of the newer welding processes such as Heliarc, the Elin-Hafergut process and automatic stud-welding machines. Apart from these additions, the book remains substantially the same as in the first edition and is still the only one available covering its specialized field. Mr. Miller has resisted all temptation to extend its scope, wisely preferring to restrict his words to the subjects on which his authority is undoubted. H. W. G. H.

Foundations of Chemical Theory

By Charles Simpson. Pp. viii+220. (London: University Tutorial Press, Ltd., 1947.) 6*s*. 6*d*.

THIS book aims at giving a concise account of the main principles of theoretical chemistry required for higher school certificate, intermediate science, pre-medical and first M.B. examinations, and providing a foundation for distinction and scholarship students. It actually contains rather less on many topics than is usually found in general text-books of this stage. More space is given to phase rule than is usual. A good feature of the book is the large number of questions and problems, which will provide useful exercises for students. Unfortunately, the book is marred by a number of minor errors, and in places insufficient detail is given to enable students to understand the principles of some experimental methods described. In a new edition the book should be carefully revised.

30-MeV. ELECTRON SYNCHROTRON

By D. W. FRY, J. W. GALLOP, F. K. GOWARD
AND
J. DAIN

Atomic Energy Research Establishment, Harwell

FOLLOWING earlier work on the conversion of a betatron to a synchrotron[1], a 30-MeV. electron synchrotron has been constructed and was first operated in October 1947. The machine is shown in Fig. 1, and employs a rectangular-yoke magnet, designed to give maximum space for experimental work. A more compact magnet, with eight C-shaped yokes, has also been designed by the English Electric Co., Ltd., for medical and industrial use, and is shown in Fig. 2; this magnet uses the same poles as that of Fig. 1, and should, therefore, give the same performance.

The machine has been operated so far only at 24 MeV. and at low gamma-ray intensity, because of temporary difficulties in protecting personnel. It is expected that the full output will be of the order of 10 röntgen/min. at 1 metre: the voltage will probably be a little less than the nominal 30 MeV. (see below).

Some of the techniques used in the construction of the machine are novel and will be emphasized in the brief description which follows. Details of the engineering practices used will, however, be omitted.

The magnet of the synchrotron weighs about three tons and provides a peak field of 10,000 gauss in an annular gap of 10 cm. mean radius; the field in the annulus varies as $(\text{radius})^{-0.7}$. The magnet is excited continuously, from the 50-cycle mains, by a resonant circuit carrying a reactive r.m.s. power of 1,500 kVa.; the losses in the circuit are about 25 kW. A betatron core is provided which accelerates the electrons to 2 MeV. (their velocity is then 0·98c), when the core becomes saturated. The laminations of the rectangular-yoke magnet are bent to follow the natural flow of flux, so far as is possible. This feature does not, however, achieve the desired result of reducing the normal field inhomogeneity of a betatron-type magnet. In particular the field disturbances due to eddy currents require correction, and this is achieved by inserting single-turn water-cooled coils between the pole shoes and the main pole cylinder. The coils are arranged to make the eddy-currents substantially equal at all points. The field homogeneity thus obtained, at injection, gives rise to a forced oscillation of the electron which occupies about one fifth of the space available for the electron orbits.

Difficulty has been experienced in starting-up the excitation circuit of the synchrotron, due to the change in the resonant frequency caused by the betatron core becoming saturated as the excitation increases[2]. This difficulty has been overcome by switching a portion of the condenser in and out. A variable choke has also been developed as an alternative method; this choke will be placed in parallel with the main coils of the magnet, and its inductance will be changed by a variable air-gap in its core. These methods allow for mains frequency changes as well as giving easy starting.

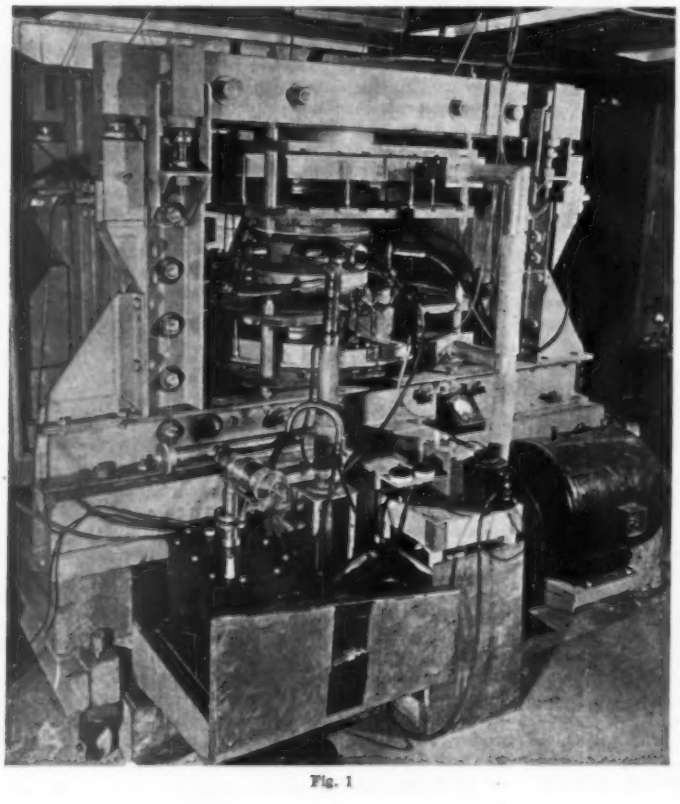


Fig. 1

Two different types of 'donut' (evacuated annular chamber) have been developed and operated. For experimental purposes a 'donut' is formed from flat plates and cylinders waxed together[3]. For general use, blown 'donuts' in *F.C.N.* glass have been constructed by the Research Laboratories of the General Electric Co., Ltd.; one of these 'donuts' is shown in Fig. 3. The synchrotron just operates at a pressure of 5×10^{-5} mm., and the output does not improve as the pressure is reduced below 5×10^{-6} mm. With both types of 'donut' a pressure of 2×10^{-6} mm. is obtained consistently, with the electron gun and resonator operating; considerably lower pressures are obtained with the gun and resonator not operating. Sealed-off blown glass 'donuts' of similar design have also been used successfully.

The electrons are injected for 2 microsec., at a voltage of 10 kV. The electron gun is the standard type of Kerst betatron gun[3], which is placed on a variable mounting and is nominally at a radius of 11·5 cm.; the gun assembly is shown on the left-hand side of the 'donut' in Fig. 3.

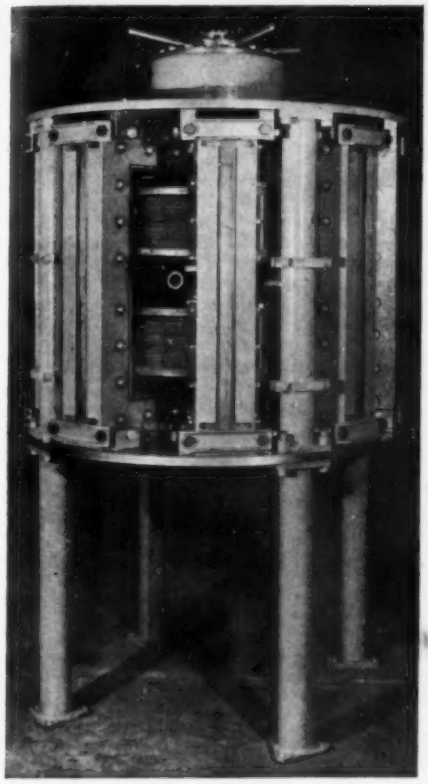


Fig. 2

The synchrotron acceleration is produced by a quarter-wave long radio-frequency resonator which is excited at 477 Mc./s. The resonator actually supplies about 10 V. per revolution to the electrons, but the voltage across its gap must be substantially greater than this, namely, about 100 V., to obtain stable synchronous operation and acceleration of a large fraction of the electrons. Some 8 watts peak power must be fed into the resonator losses to produce this voltage. In addition, power must be supplied to the electron beam to accelerate it. If the beam current in the synchrotron is assumed to be 1/100 microamp. at full output, the mean power required to accelerate this current to 30 MeV. is 0·3 watt, which means that the peak power required to be fed into the electron beam is about 2 watts. The total power required is, therefore, about 10 watts peak, and to give a safety margin 20 watts peak power is supplied to the resonator by a continuous wave oscillator and modulated amplifier. The relatively high efficiency of the resonator in this low-energy machine contrasts with the efficiency obtained in higher-energy machines, say 300 MeV., where the losses in the resonator are larger compared with the power used in accelerating the beam.

Two types of resonator have been developed, both made from high permittivity ceramic with a conducting silver coating fired on to it. The silver forms the inside and outside conductors of a coaxial line, and also forms the shorted back. A narrow accelerating gap in the inner conductor is burned by an arc. The resonators are made of Steatite and Porcelain Products Co.'s materials 'Tempradex', dielectric constant 15, and 'Faradex', dielectric constant 80. The resonators are so short that they need not be moulded to a circular shape as would be necessary with an air dielectric. The 'Faradex' resonator in particular is so small that no appreciable eddy currents are produced in it by the main field. It is therefore unnecessary to laminate it, and, further, it can be inserted into the 'donut' through a side-arm. The resonator is supported on a coaxial line which feeds it; it also has a second coaxial line attached, to monitor the voltage across the gap. The walls of the resonator are $\frac{1}{4}$ in. thick, and the internal conductor forms a rectangle 4·1 cm. wide × 2·8 cm. high; this dictates the area which is available for the electron orbits. Fig. 3 shows the resonator assembly, withdrawn from the 'donut' side arm.

The tungsten target is mounted internally and acts as a thin target. The electron orbits are allowed to shrink on to it, by switching off the radio-frequency accelerating voltage before the peak field is reached. This means that the acceleration ceases when the field at the equilibrium orbit is just over 9,000 gauss, which corresponds to an energy less than the nominal 30 MeV., namely, 28 MeV.

The switching operations required during each magnetic field cycle are the triggering of the electron gun modulator, the switching on and off of the radio-frequency, and the starting of the trace of the cathode ray tube display. This sequence was originally controlled electronically by pulses formed from multivibrators, which gave variable time delays relative to the pulse from a peaking transformer. This transformer was made from a strip of permalloy wound with a small coil and placed in the magnet gap. This system required frequent adjustment during operation, since the fields at which the switching occurred were dependent on the somewhat variable mains frequency. A system is now being used consisting of a series of peaking transformers, placed in series with the magnet excitation coils, and biased by D.C. windings to vary the field at which the pulses are produced.

A photograph of the main cathode ray tube display when the synchrotron is operating is reproduced in Fig. 4. The upper trace shows the rise of the magnetic field; its horizontal displacement is proportional to the field. The lower trace shows the falling magnetic

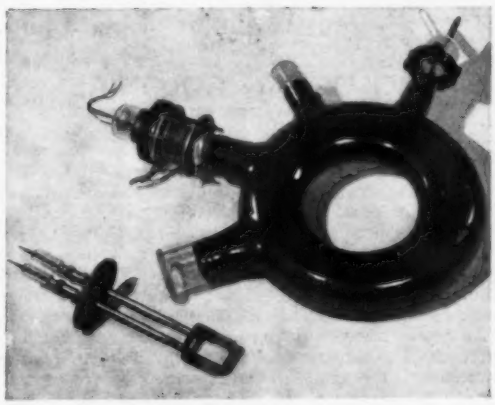


Fig. 3

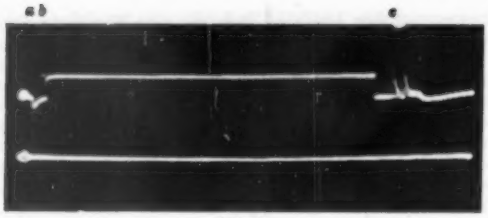


Fig. 4

field; this trace is needed when the gun is used as a target by switching off the radio-frequency at the peak field and allowing the electron orbits to expand. On the trace shown may be seen the zero field pulse, *a*, the envelope of the rectified radio-frequency accelerating voltage, *b*, and the response, *c*, from a Geiger–Müller counter placed in the γ-ray beam. The response appears as a double pulse, a phenomenon which has been already investigated on the American 70-MeV. synchrotron, which has sufficient intensity to actuate a photomultiplier tube[3].

The experimental results so far obtained with the synchrotron are qualitatively in agreement with previous results reported[1,2]. This first 30-MeV. machine will continue to be used to develop synchrotron techniques and to guide the design of the 140-MeV. and 300-MeV. synchrotrons which are being constructed. One of the later 30-MeV. machines, now in the stage of final commissioning, will be used as a nuclear physics tool by the Physics Department of the University of Glasgow. Two further machines are being built for the Medical Research Council for medical investigations. In addition, a machine has been modified to test whether a frequency-modulated synchrotron is practicable.

Acknowledgment is made of the assistance given to this project by our colleagues at the Telecommunications Research Establishment and by industrial firms and potential users of the machines. It is hoped to make full acknowledgment of these contributions in later descriptions of more specialized features of the apparatus. The work described here was carried out by the Electronics Group of the Atomic Energy Research Establishment, at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Sir John Cockcroft for permission to publish the results.

[1] Goward and Barnes, *Nature*, **158**, 413 (1946).
[2] Elder, Gurewitsch, Langmuir and Pollock, "A 70 MeV. Synchrotron", *J. Appl. Phys.*, **18**, 810 (1947).
[3] Kerst, *Rev. Sci. Instr.*, **13**, 387 (1942).

BIOLOGY IN COLONIAL UNIVERSITIES

PLANS which are in train or which have already been carried out for the setting up of university colleges in the West Indies, at Singapore, at Ibadan, Nigeria, and in the Gold Coast, as well as for the extension of Makerere College, Uganda, give point to the parallel discussions which have been going on with regard to the content and outlook of the curriculum which should be offered in these centres of higher education for Colonial people. It has been generally agreed that subjects contributing directly to human welfare should receive greater attention than has been the case in the more ancient seats of learning in Britain; it has also been generally agreed that the subjects offered should form part of some concerted scheme. With such ends in view Dr. E. B. Edney makes out a case for the setting up in Colonial universities of single departments of biology instead of separate ones for botany and zoology[1].

Dr. Edney has had experience of Colonial education as tutor in biology at Makerere College. In his article he directs attention to the fact that many problems coming under botany and zoology are really biological; the biological approach to them is more vital and organic. For students working to 'pass' standards—and these for some time to come will be the great majority at Colonial universities—botany and zoology as taught at present, he maintains, are too morphological. One reason for this is that all human physiology is taken over by the medical schools.

So far as Colonial universities are concerned, the question may be debated in relation to three main functions: the training of teachers, applied scientists, and research workers. As regards the first it is suggested that at the school stage the aim should be to develop a biological approach built around the concept of the organism in relation to its environment. As for applied scientists, whether agriculturists, entomologists or medical practitioners, problems in the field are always biological. Training, therefore, should include instruction in biological relationships. Under present conditions such training is given only as part of vocational work.

In relation to research, Dr. Edney maintains that, in any event, a biological approach could not have a stifling effect, and that the association of workers interested in both plant and animal biology should prove a fruitful one. Fields of research like genetics, cytology and ecology are not either purely botanical or zoological, yet they are as important and attractive as any others. It might be objected that the biological approach is too general and superficial, and that concentration on the morphological and systematic aspects of the subject is necessary for developing accuracy and an appreciation of scientific discipline. The author admits that the subject of biology is far too wide to be covered adequately in a course of two or three years, but he sees no reason why accurate and painstaking work should not be done in fields which are essentially biological, while at the same time giving due weight to considerations which are chiefly morphological.

If it is agreed that the biological approach is of value, the question remains whether the subject should be presented by two separate departments or one. For a number of reasons Dr. Edney holds that the latter would be preferable. Existing departments of zoology and botany have their own distinctive flavours; while as regards examinations, if for the new Colonial universities they are to continue to be directed from London, a single department of biology would find it easier to devise and gain acceptance for its own syllabus. Where new universities are being founded, the setting up of a department of biology would be comparatively easy; where separate departments for botany and zoology already are in being, it might be advisable to allow them to continue, while working progressively towards closer union.

A point not touched on by Dr. Edney is the question of staffing. The supply of men of science with a genuine biological point of view is small and it is not likely rapidly to increase. To present at university standard a syllabus of the type envisaged would require the close co-operation of several men of

science. While that would be highly desirable in itself it would not be easy to achieve. At the same time, a demand for biologists, as distinct from botanists and zoologists, would have repercussions on the universities in Britain which in the long run would be likely to be salutary.

As an appendix to his article, Dr. Edney has drawn up a three-year curriculum in biology to pass-degree standard, which may be obtained on application.

[1] *Biology and Human Affairs*, **13**, 111 (1948). (British Social Hygiene Council (Inc.), Tavistock House North, London, W.C.1.)

EDUCATION IN MYCOLOGY

THE first duty of Prof. A. E. Muskett as president of the British Mycological Society for the ensuing year was to preside at the discussions of the Society on "Mycological Education" at its meeting on January 31. In the first paper of the session, "The Society and Mycological Education", Dr. G. C. Ainsworth reminded us that mycological education is implicit in many of the activities of the Society, not the least of these being the annual foray where amateur and professional mycologists forgather for a week of intensive study of fungi collected on daily excursions. This club meeting has done much to keep alive the "tradition of species". By its report on "The Need for Encouraging the Study of Systematic Mycology in England and Wales" printed, but not published, in 1944, and by its subsequent report on "The Teaching of Mycology" printed in 1946, but again not published, the Society focused attention on the dearth of trained mycologists and of systematists in particular, and on the need for detailed consideration of, and early action to secure, the adequate training of mycologists in the diverse fields in which present-day conditions require their services. The discussion afforded the exchange of views on the question of mycological education between mycologists of widely different interests.

Admitting that the topic of education for a specific career is always a difficult subject to review, Dr. W. G. Keyworth, in presenting the case of "Mycology for the Plant Pathologist", outlined the present course of training of a plant pathologist during the study for his initial degree. Here mycology is treated in the same way as other aspects of botany, emphasis being placed on those families showing features of taxonomic interest. Research on a specific and often rather limited field of investigation usually followed before the plant pathologist embarked on his career as an adviser or as a research worker. Valuable as the present system is, Dr. Keyworth considers that continued study of general mycology after taking a first degree is of paramount importance. This study should not only include pathogenic but also saprophytic fungi, should involve a consideration of the Fungi Imperfecti, should deal with the study of the fungi *in vivo* and *in vitro*, and should include an adequate treatment of the taxonomy of fungi. Thereafter, and before commencing professional duties, the plant pathologist destined to become an adviser might gain experience in field recognition of diseases at an advisory centre, and the plant pathologist following research work as a career might gain experience in research methods and technique as applied to pathogenic fungi. Dr. Keyworth concluded by suggesting that postgraduate courses should be instituted, and that these might well lead to a diploma or to a higher degree which could be the accepted hallmark of a sound preliminary training.

The absence of courses which completely cover the requirements of industrial microbiologists was emphasized by Dr. F. D. Armitage during his paper on "Mycology and the Industrial Microbiologist". Certain microfungi are studied as examples of moulds in courses of bacteriology, but to obtain a working knowledge of systematic mycology the microbiologist must depend on private reading of current literature —a task almost impossible without some expert guidance. He suggested that the Society might use its influence to create a school of mycology which would develop a course suitable for mycologists in industry, paying particular attention to mycological technique, to the maintenance of culture collections, to the sampling methods applied to mycological analysis, to the study of inhibitors and to the principles of taxonomy. Failing this, the Society might organise, and later publish, a series of lectures designed for those commencing the study of microfungi. He was certain sound mycological education is a vital problem at the present time.

During his paper on "Mycology for the Medical Practitioner", Dr. I. Martin Scott suggested that the practitioner's lack of intimate knowledge of this branch of science was due to the overloaded curriculum of the present degree and to the lack of facilities for graduate studies. Normally only a single lecture is devoted to pathogenic fungi during undergraduate courses, and in public health studies only a short course on medical mycology is available. The remedies are obvious: future undergraduates should receive systematic instruction in mycology, as they do now in bacteriology, and graduate schools for further study and for research should be established. Close collaboration between medical practitioners and mycologists is essential in this field.

The case for "Mycology for the Amateur" was ably presented by Mr. J. M. B. King, who stated that the Society offers the best place for the amateur, who takes his mycology seriously, to obtain that advice and guidance which the personal experience of its members, obtained by the study of fungi in the field, can give. The Society could further aid the amateur by sponsoring books written in as non-technical a language as possible containing adequate keys, colour charts and fully documented glossaries of necessary technical terms. He believed that periodic publication in its *Transactions* of articles dealing with the fundamental features of fungal structure, with the principles of classification and with taxonomic problems would be appreciated. Efforts might be made to increase the number of forays and of meetings of general interest, some of which might be demonstrations of named specimens similar to that recently held.

Dealing with "Mycology and the Universities", Prof. C. G. C. Chesters stated that the orthodox training in mycology was obtained within the scope of an honours degree in botany, the fungi being treated as a section of the Thallophyta. He believed that the fungi should be removed from this phylum and might be treated as a separate discipline within the confines of botany. Since mycology must be based on a knowledge of the living fungus, collection of material in the field must play a large part in any well-balanced course, which must also include the study of the physiology, the genetics and the technique of cultivation of fungi *in vitro*. Graduate

studies of a more detailed character should precede research investigations. Suggesting that there might well be a place for a more heterodox training in mycology, he outlined a course for an honours degree in which, during the years subsequent to intermediate studies, chemistry, botany (excluding the fungi) and mycology should be studied as parallel courses for two years and should be followed by a final year devoted entirely to mycology. The principles of bacteriology should be introduced during initial studies in mycology.

Mr. L. M. J. Kramer, speaking on "Mycology in Relation to Schools", said that it was mainly during study for the higher school certificate or the university entrance examinations that the implications of mycology and the future openings for those able to undertake the necessary training could be presented to the scholars. Teachers would appreciate articles on simple laboratory exercises, on current trends in mycological studies and on openings for mycologists, as well as details of the necessary training, in such journals as the *School Science Review*.

In the discussion which followed the papers, Dr. Wilkins supported the separation of mycology from botany and hoped that the Society might influence university opinion to recognize mycology as a special subject for study. Dr. J. Ramsbottom considered that Mr. Kramer's suggestion that there was a lack of trained science teachers raised an important topic and stated that, while he would not enter the argument for or against mycology being taught as a discipline separate from botany, it was essential to realize the great development of mycology during the past few years. Progress in teaching industrial mycology is slow at present but nothing can stop the development of this line of study. The hope for medical mycology lies in the fullest co-operation of the mycologist and practitioner. He believed the possibility of a bulletin for amateurs sponsored by the Society might be considered. Mr. Large pointed out that plant pathologists had to be more than professional mycologists and that there was a decided lack of good drawings and simple descriptions of fungi. Dr. Wood was against any separation of botany and mycology and emphasized that plant pathologists had to be botanists. Dr. Cook believed that botany was outgrowing itself, that the difference between green plants and fungi was fundamental and that there was a place for a specialized mycology course following a general degree with botany as one of its subjects. Dr. Prentice deplored early specialization and considered that specialized graduate studies should follow a liberal first degree course. Dr. Keyworth thought a degree in botany was of fundamental value and that the necessity of a lengthened period of training by the introduction of postgraduate courses must be considered.

Reviewing the papers and the subsequent discussion, Prof. C. T. Ingold reminded members that the Society had developed from a field club to assume the lead in mycological thought in Great Britain without losing the essential characters of a field club. Its reports demonstrate its vital interest in adequate provision for mycological education and its encouragement of taxonomic studies. Believing that the greatest weight should be placed on special postgraduate courses, Prof. Ingold referred to the present contribution of individual departments and suggested that industrial mycology might be established at technical colleges and, when medical education is reorganised, a place should be found for medical mycology. He considered that fungi should be treated outside the Thallophyta and that a reunion of bacteriology and mycology would be advantageous. Additional literature on the systematic side is urgently required. Prof. Ingold concluded by suggesting that the Committee of the Society which dealt with the teaching of mycology might continue its deliberations in the light of these discussions and might consider the institution of special series of lectures on mycological topics.

CHARLES G. C. CHESTERS

A TRIBUTE OF INDUSTRY TO SCIENCE

A SPECIAL meeting of the Industrial Research Committee of the Federation of British Industries was held at the Royal Institution on March 19 in honour of Sir Robert Robinson and Sir Edward Appleton, who received the Nobel Prizes in 1947 for Chemistry and for Physics, respectively. Sir Frederick Bain, who presided, pointed out that not since 1904 had the prizes for chemistry and physics both come to Great Britain undivided and undisputed, although since 1901 Britain has had no less than thirty-six Nobel Prize awards in the five different categories. He described the meeting as a whole-hearted demonstration by British industry of pleasure at this authoritative recognition of the work of Robinson and Appleton, who now shared the distinction of Sir William Ramsay and Lord Rayleigh in 1904, and also a sincere recognition of what industry owes to science as represented by them. Sir Frederick said that he had been privileged to work intimately both with Sir Robert and Sir Edward, and that during the War we had learned how the scientist and industrialist could work together for a common objective. Great scientists could be effective men of affairs, and through the example and devotion of men like Robinson and Appleton, Britain had become, in war as in peace, not only a country of the questing mind and free experimental approach but also, above all, a place for sharing ideas, improvisation in emergency and effectiveness in application of scientific work.

Sir Robert Robinson, in a brief address on the "Scope of Organic Chemistry", referred to the way in which contact with industry has enriched our knowledge of organic chemistry, to the great stimulus which the study of complex molecules has given to organic chemistry and conversely to the contribution of organic chemistry to the development of the biological sciences. After referring to the opportunities for co-operation between different scientific workers afforded by such fields as catalysis and polymerization, and to the evolution in the last twenty years of the industry of aliphatic chemicals, Sir Robert stressed the national importance of organic chemical industry. In this connexion he urged the extension of facilities for research in organic chemistry and stressed the function of the universities in training research workers. For that function to be discharged effectively, parallel with the growth of industrial research laboratories and the expansion of technical colleges, there should be higher salaries for science teachers and the enlarging and modernization of university departments.

Sir Edward Appleton's address, "The Scientist in Industry", discussed in greater detail some aspects

of the balance of the scientific effort of Britain now that it has recovered from the distortion due to our war effort. That effort, and particularly the development of the atom bomb, illustrated the rapidly increasing momentum of scientific and technical progress and the way in which the lag between scientific discovery and its practical application can be decreased. Sir Edward, emphasizing the importance of avoiding any segregation of our research effort whether in the universities, in Government departments, or in industry, said that while in the university, where fundamental scientific research is mainly conducted, the only discipline is that of science itself, in Government and industrial research there is the further discipline of specified objectives, wide though these may be. The more liberally the restrictions imposed by the nature of the organisations which such scientific workers serve are interpreted, the better the scientific health of the men who work in them. Sir Edward then spoke of the broad lines of policy pursued by the Department of Scientific and Industrial Research, and of the necessity of a wise use of men of science in industry. He attributed our success in the War very largely to the mutual understanding which developed between the General Staff, the scientific workers and those responsible for production; and we need in peace the same sense of partnership between management, scientific men and other workers in industry. Commenting further on the importance of the human aspects of the scientist's work, he urged that the discipline of science should result in complete impartiality in interpretation, and that the scientific worker should make his own contribution to the simplification of managerial decision, and particularly by clarity in expounding the results of his work. He described 'operational research' as meaning the application of scientific methods to the quantitative estimation of the effect of the changes in all kinds of factors which might influence industrial efficiency; and he said that, while industry before the War had often sought in this way to obtain reliable data as a basis for executive decisions, such methods could be of particular value at the present time in enabling science to contribute effectively to the increase of national productivity. The research associations are admirably fitted for such work.

The scientific worker in industry, Sir Edward said, has three principal functions: first, to provide a scientific service for his firm or industry; secondly, to carry out research aimed at devising new or improved processes, goods and materials; and thirdly, to contribute to the world's stock of scientific knowledge. He believed that what scientific workers value most is the good opinion of their scientific colleagues, and it is impossible for them to feel they can acquire and retain this if their work is so circumscribed and limited in outlook as to cut them off entirely from the main stream of scientific progress. What matters most is not money and equipment, but men and leadership—above all, leadership which understands men.

Sir William Akers, in a tribute to Sir Robert Robinson, spoke of the extreme elegance of his methods as the distinguishing characteristic of his work on complex organic molecules ranging from the anthocyanins and alkaloids to the sterols, in which he had made organic chemistry a branch of physical chemistry. His approach and methods in dealing with a problem were of intrinsic beauty, and this elegance was matched by his personal modesty. Sir William Larke, in a tribute to Sir Edward Appleton, referred not only to his work on the exploration of the ionosphere and his contribution to the development of radar, but also to his fine and human leadership of the Department of Industrial and Scientific Research. Sir William particularly welcomed Sir Edward's reference to the importance of exposition and interpretation, and to the view of operational research as a normal function of management. It was most fitting that the meeting should be held in the Royal Institution, where Faraday and others had carried out so much work upon which industrial development was based.

A complimentary dinner was given by the Federation to the two Nobel prize-winners that evening, and there were present the Prime Minister, the Lord President of the Council, the Minister of Food, the Minister of Fuel and Power, Lord Samuel, Lord Hankey, Lord Addison, Lord Cherwell and Sir John Anderson, the High Commissioners of New Zealand, India, Canada, Australia and Eire, and many other public men. The Prime Minister proposed a toast to the two guests of honour, saying that the recognition by the Federation of British Industries of the work of these two great men of science showed that the Federation appreciates the vital necessity for Britain to use to the full the resources of science if we are to hold our own in the modern world—and, he added, we are going to hold our own. He believed that industry is more alive than ever to the value of fundamental research, and he paid a tribute to the work of the Department of Scientific and Industrial Research. He hoped that the National Development Corporation would help to fill any gaps in the development of scientific discovery to full-scale production, and while the award of the Nobel Prizes to Sir Robert Robinson and Sir Edward Appleton showed that we are recognized as in the front rank in the field of science, he believed that Britain still has an immense contribution to make to the progress of the world.

Sir John Anderson, who seconded the toast, dealt more particularly with the scientific achievements of the two prize-winners, and stressed the importance of Sir Edward Appleton's work for radar during the War, and of Sir Robert Robinson's work for the supply of drugs and medicinals in the First World War. Sir Robert's rise to fame, in fact, coincided with the rise of the organic chemical industry in Britain, and Sir John remarked that while Britain has often led the world in fundamental science, we have not been quite so good in following up fundamental discovery.

Sir Robert Robinson, in responding to the toast, paid a warm tribute to the work of the many colleagues associated with him in his researches over the last forty years, among whom Lady Robinson had already been mentioned by the Prime Minister in a charming little tribute. Sir Edward Appleton, who also replied, said that in looking back over twenty-five years of research, he could not recall any sudden flashes of insight, although there had been many exciting moments. He reminded his audience that really great achievements are sometimes accidental and unintentional, and we should not be concerned exclusively with the material consequences of science. Science enlarges men's minds and could bring home to everyone the wonder and significance of the world in which we live. Science-teaching in our schools and universities should be far more than merely vocational training. In the international sphere, science means

knowledge, and knowledge means power. Like other men, the scientific worker is deeply perturbed and morally concerned about the use or misuse of scientific knowledge. Atomic energy, for example, in itself threatens no one; but the possible use of atomic energy by nations prompted by hatred, envy or fear brings a new apprehension in our lives. The problems raised by this challenge are not for the scientific worker alone, though he has a right to his own views as a man of science; and Sir Edward stoutly supported a scheme of adequate international control at the present stage of the world's moral development, even while looking forward to a world in which such control would be unnecessary.

OBITUARIES

Sir Charles Grant Robertson, C.V.O.

Sir Charles Grant Robertson, who had been principal and, after the amendment of the University Charter in 1927, vice-chancellor of the University of Birmingham from 1920 until 1938, died at his home at Ringwood in Hampshire on February 29. Born in 1869, he passed from Highgate School to Hertford College, Oxford. There he had a brilliant career, being elected a fellow of All Souls in 1893. At Oxford he earned a reputation as a distinguished historian. In 1920 he was appointed principal of the University of Birmingham, to succeed Sir Oliver Lodge, the first principal, who had retired in 1919.

On the outbreak of war in 1914, the main buildings of the University of Birmingham at Edgbaston were immediately taken over by the War Office and converted into the First Southern General Hospital, and what was left of staff and students was scattered to various crowded and inadequate quarters in the city. At the end of the War in 1918, the problem of reconstruction was immense. The buildings had to be cleared and restored to their proper functions and a battle had to be waged with the War Office for the cost of reconversion. Many temporary huts had to be erected to accommodate the flood of undergraduates surging in after demobilization, staffs had to be increased and money had to be raised. The University was heavily in debt and new and costly buildings were essential. An appeal for half a million pounds was therefore launched. The new principal used his remarkable powers of eloquent persuasion, both in public and in private, to great effect, and soon large sums came in from generous Birmingham benefactors, and some of the much-desired ideals became realities. The new Biological Block was built; to the department of chemistry was added the Hills Chemistry Block; and through the munificence of Sir Charles Hyde the Hall of Residence (Chancellor's Hall) and the Students' Union came into being. Sir Charles Grant Robertson used his organising abilities to get a better balance between the faculties by the development of the Arts side and extending the Library. A faculty of law was established, with a chair endowed by Mr. Henry Barber.

Another project dear to the heart of the principal was the building and endowment by Lady Barber, in memory of her husband, of the Barber Institute of Fine Arts. This Institute, which has a beautiful music room in addition to its picture galleries, provides the students with rare opportunities for cultural education outside the routine courses. Behind all this development was always the energetic personality of Sir Charles.

But perhaps the greatest and most far-reaching of Sir Charles' activities was his advocacy of the Hospitals Centre, with an associated medical school. For thirteen years he laboured unceasingly as chairman of the Hospitals Centre Committee with a generous, energetic and resourceful band of fellow citizens, and finally had the satisfaction of seeing the completion (or, perhaps more exactly, 'the end of the beginning') of their work in the form of the great Queen Elizabeth Hospital, in front of which extends the magnificent building of the Medical School, a visible monument to the solidarity of the University and the City. The persistent energy with which Sir Charles Grant Robertson worked for the advancement of the University of Birmingham in all its branches has left an abiding mark on the great city of whose long line of great 'peaceful invaders' he was not the least.

G. A. Shakespear

Mr. Griffith Brewer

By the death of Mr. Griffith Brewer on March 1, the fraternity of aeronautical pioneers has lost a well-beloved and much respected friend. Brewer was born in London in 1867 and was by profession a patent agent. For nearly sixty years his chief interest lay in aeronautics, and he was not only an authority on aircraft patents but also a notable balloonist and, later, an aviator who bore the distinction of being the first Englishman to fly in an aeroplane—as a passenger with Wilbur Wright in 1908. Abroad, he was perhaps best known for his work and friendship with Wilbur and Orville Wright and, in particular, for the part he played in the so-called 'Wright–Langley controversy'.

Griffith Brewer was a man of marked integrity and courage; he displayed these virtues to the full when investigating and exposing the claims made in respect of Prof. Langley's 'aerodrome' after its reconstruction and flight in 1914—claims which he regarded as damaging to the credit of the Wright brothers. He was instrumental in 1928 in obtaining the original Wright aeroplane of 1903 for exhibition in the Science Museum, London, as a further step towards securing unqualified recognition of the Wrights' achievement. This recognition is now happily established and shortly to be confirmed by the return of the machine to the United States for preservation in the National Museum at Washington. His vindication of historical truth in that issue is likely itself to pass into history. In 1913, Brewer was entrusted with the formation of the British Wright Company to administer the Wright brothers' patents in England.

Brewer obtained his pilot's licence at Dayton, Ohio; in 1933 he gained a licence for flying autogiros. He served for many years on the Council of the Royal Aeronautical Society, of which he was a past-president; and in 1912 founded the Society's Wilbur Wright Memorial Lecture. His gentle presence and kindly nature will be missed there. M. J. B. Davy

We regret to announce the following deaths:

Prof. A. S. Eve, C.B.E., F.R.S., emeritus Macdonald professor of physics in McGill University, on March 24, aged eighty-five.

Prof. M. C. Potter, emeritus professor of botany in the University of Durham since 1925, on March 9, aged eighty-nine.

NEWS and VIEWS

Sexcentenary of the University of Prague

THE decree of Charles IV, king of Bohemia, founding the Universitas Carolina, now the University of Prague, was dated April 7, 1348. Its sexcentenary was to have been celebrated by an international gathering; but events in Czechoslovakia have led to the withdrawal of acceptances of invitations by universities of Britain, on the ground that the University no longer enjoys its academic freedom. Charles' decree appointed the archbishop, Arnošt of Pardubice, as chancellor and stipulated that it should "serve the cultural needs of the Bohemian people, that they should no longer beg at foreign tables but have a worthy feast brought to their own table". At first, instruction was in Latin, and being one of the few educational centres it attracted many German and other students. During the rectorship of John Hus at the beginning of the fifteenth century, the Czechs were outvoted in administrative appointments. This led to the famous Kutná Hora decree of King Wenceslas, in 1409, giving the Czech 'nation' three votes and the others (German, Polish and Silesian) one each, an action that led to the departure of the Germans and hastened the founding of the University of Leipzig in 1411.

Religious matters often dominated university life, and many *magisters* found themselves against ecclesiastical and royal authority, especially after the advent of the Habsburg rulers in 1526. The botanist, Zaluziansky, was rector about 1600 and tried in vain to secularize the University; when the Czechs lost their independence in 1620, Ferdinand II installed Jesuit teachers and it became the Charles-Ferdinand University. A long period of stagnation followed, but eventually it regained some of its earlier significance, and during the nineteenth century several professors achieved world-wide reputations. Czech was again used by some, and in 1882 the University was divided into Czech and German institutions. These endured through the period of the first republic until Czech higher educational establishments were closed by the Nazis in 1939. The Charles University reopened in 1945 and had to cope with six years accumulation of students and with teaching staff depleted through age and executions. In the present academic year there are altogether 23,977 students (including 5,423 medical, 4,977 philosophy, 2,181 science) and provision has been made for research work in practically every subject.

Duddell Medal of the Physical Society: Dr. R. J. Van de Graaff

THE Duddell Medal for 1947 of the Physical Society has been awarded to Dr. R. J. Van de Graaff, of the Massachusetts Institute of Technology, in recognition of the invention and development of the high-voltage electrostatic generator already known by his name. To Van de Graaff belongs the credit of making a type of particle accelerator based on the simplest possible conception. Electric charge, sprayed on to a moving belt, is carried into a sphere, acting as a Faraday cage, until the potential rises to the desired value. The full potential to be applied to the particles thus exists between the sphere and the earth, and the great practical difficulty is to avoid discharges at undesired positions and corona losses. Van de Graaff overcame all these difficulties and so long ago as 1937 he exhibited at the Paris Exhibition an apparatus producing 4,000,000 volts. Sets for 10,000,000 volts have more recently been built and operated successfully. Dr. Van de Graaff will receive the Medal at a meeting of the American Physical Society in Washington, D.C., on April 29; the presentation will be made by the British Ambassador, Lord Inverchapel.

Chemistry at University College, London: Prof. E. D. Hughes

RECENTLY the Chemistry Department of University College was reinforced on the side of inorganic and physical chemistry by the addition to the staff of Dr. Kathleen Lonsdale; now organic chemistry in the Department is to be strengthened by the appointment of Prof. E. D. Hughes to the additional chair of chemistry which the Senate of the University has just created. The other professors in the Department are Prof. S. Sugden and Prof. C. K. Ingold. Prof. Hughes was originally trained in the University of Wales. His first researches were carried out during 1927–30 at Bangor under the leadership of the late Prof. Kennedy Orton and Dr. H. B. Watson. In 1930 he went to London to work with Prof. Ingold at University College, and in 1934 joined the staff of that College. There he formed an active research group, closely integrated with that of Prof. Ingold. In 1936 he received the Meldola Medal, which is awarded for the most distinguished chemical work carried out under the age of thirty. In 1943 he was appointed professor of chemistry at University College, Bangor, thus succeeding to a chair which his former master, Prof. Orton, was the first to make famous.

Prof. Hughes is distinguished for his researches on the mechanism and kinetics of organic reactions, particularly in relation to substitution and elimination. He discovered and firmly established the unimolecular forms of these reactions, and made many extensions of these basic observations, for example, to the elucidation of the multiform mechanisms of carboxyl esterification and hydrolysis, and to the clarification of the conditions for the Walden inversion. In these studies he has made considerable use of both radioactive and non-radioactive tracers: the stills at Bangor for the production of heavy oxygen are probably the most powerful in existence. His most recent work refines the concept of steric hindrance, provides direct evidence concerning the formation and stability of the nitronium ion and its role in nitration, and defines the mechanisms operative in anionotropic change. He has published more than ninety original papers.

Geography at Bedford College, London: Mr. Gordon Manley

MR. GORDON MANLEY will go to the newly created chair of geography at Bedford College, University of London, with wide experience of university life in Britain and as an acknowledged authority on climatology. Mr. Manley graduated at both the Universities of Manchester and Cambridge, where he was an exhibitioner of Gonville and Caius College, and he has held university posts successively at Birmingham, Durham—as first head of the Geography Department—and Cambridge. His interests in the meteorological aspects of snow-cover may have derived from his enthusiasm for the Pennines and the Lake District

as a keen mountaineer and rock climber as well as geographer. A visit to East Greenland as a member of Mr. J. M. Wordie's expedition of 1926 confirmed these interests. More recently he has analysed long-period temperature records in the north of England and revealed the gradual warming of our winters since 1820. The close resemblance between these changes and those for Stockholm suggests that this matter is of far more than local significance. In these early records Mr. Manley sees a valuable source of information that may throw light on the greater climatic changes of the Pleistocene Ice Age. Mr. Manley is, too, a keen but balanced advocate of the geographer's contribution to meteorology. This was the theme of his second presidential address to the Royal Meteorological Society. The Buchan Prize in 1943, the Symons Lecture in 1944, and the Murchison Grant of the Royal Geographical Society in 1947, all marked Mr. Manley's contributions to climatology; but his papers also include other branches of geography, particularly the history of cartography. Mr. Manley remained at Cambridge long enough to see the University give somewhat belated recognition to meteorological studies by setting up a Meteorological Committee, of which he was the first secretary.

Iron and Steel Institute Awards

THE Council of the Iron and Steel Institute has made the following awards: Bessemer Gold Medal for 1948, to Mr. W. J. Dawson, formerly of Hadfield's, Ltd., in recognition of his contributions to the development of steel castings and to the production of alloy and heat-resisting steels; Sir Robert Hadfield Medal for 1948, to Mr. A. Preece, reader in metallurgy in the University of Leeds, in recognition of his researches on the scaling and on the overheating and burning of steel; Williams Prize for 1947, to Mr. R. Fowler, of Richard Thomas and Baldwins, Ltd., for his paper on "Blowing out a Blast-Furnace", printed in the *Journal of the Iron and Steel Institute*, **155**, 513 (1947). The presentations will be made on May 5 during the annual general meeting of the Institute.

American Institute of Biological Sciences

AN American Institute of Biological Sciences has recently been established. The rapid advance of the biological sciences and their impact on human welfare have created new problems relating to the development and application of those sciences. During recent years many biologists have recognized that the biological sciences suffer from the lack of a service organisation, which would help the various biological societies to discharge more effectively those functions which are of common concern to them all, but which they cannot adequately exercise as individual societies. The new organisation is designed to fill this need as well as to serve the biological sciences in other ways. A governing board has now elected the officers and an executive committee. Recognizing the potential importance of this new undertaking for the advancement of the biological sciences, and through them for all biologists, the U.S. National Research Council has not only endorsed the programme, but has also agreed to make available the general services of the Council. As a part of the National Research Council, the Institute will also provide biologists with an agency through which they can maintain close relations with governmental activities and with other fields of science represented within the Council.

The Fall Webworm of North America in Europe

DR. PAUL SURÁNYI, University of Agricultural Sciences, Budapest, states in a letter that the first specimen of the moth of fall webworm (*Hyphantria cunea* Drury) to be caught in Europe was found in the vicinity of the Danubian Free Port of Budapest in 1940. Hitherto it has not been observed outside the United States and Canada. The way it has increased shows that its caterpillar has found very favourable conditions of life in Europe. Nests of the caterpillars were first observed in 1943; since then it has increased rapidly, and during 1945–46 it did considerable damage in orchards and on various trees. It was distributed over a semicircular area with a diameter of 80 km. in 1946, which has now increased to 200 km. Indeed, this destructive insect has overrun two-thirds of Hungary, has reached the borders of Czechoslovakia and Yugoslavia, and is approaching those of Austria and Rumania. North of Budapest it is seldom observed, due probably to the prevailing north to north-west wind. Its favourite feeding-plants—the same as in North America—are *Acer negundo* L. and *Morus alba* L., from the latter of which it strips the leaves in groves and along the highways. But it feeds on all fruit-bearing and garden trees, and—what is much more dangerous—it has established itself also in the woods. Fifty-eight species belonging to different genera are known to be food plants; they include oak (*Quercus* spp.), alder (*Alnus glutinosa L.*), black locust, (*Robinia pseudacacia* L.), common stinging nettle (*Urtica dioica* L.), cabbage (*Brassica oleracea* L.), and also horseradish (*Armoracia lapathifolia* Gilibi). Two generations of the fall webworm normally hatch in a year. Its swift spread seems to be due not only to suitable conditions, but also to the fact that, so far as Dr. Surányi's experience goes, the caterpillars are seldom attacked by European parasites.

Mechanics of Packings of Granular Material

IN view of the many technological fields where an understanding of the properties of granular materials is fundamental, it is surprising that there has been little systematic investigation, the present inchoate body of knowledge being derived from *ad hoc* studies. In reviewing the more recent literature, D. R. Hudson (*Machinery*, **70**, 617, 681; 1947) discusses work on packings of material in bulk carried out by investigators in the fields of geology, fuel technology, the ceramic industry, civil and chemical engineering, and powder metallurgy. This widespread interest may account partly for the diffuse study in industrial research. On the academic side the present preoccupation with the fine-structure of matter has led to the neglect of Osborne Reynolds' pioneer work on packings, undertaken in the 1890's in an attempt to provide a mechanical explanation of the universe.

Hudson's review is more concerned with the structure and characteristics of a compacted granular bed—the voidage and number of interparticle contacts and their dependence on particle size and size distribution, the relative size and the shape of the container—than with the effect on the structure of deformation of the packing, which is of especial importance in earth pressure theory, in the study of handling and conveying mechanisms and in the design of hoppers, bunkers and silos, where Reynolds'

principle of dilatancy provides a key to the construction of force diagrams. Nevertheless, Hudson emphasizes the complex character of packings as opposed to the ordered structures of crystallography and the random assemblies of statistical mechanics, and implies the impossibility of deriving a satisfactory theory of packings as an extension of the geometry of ideal ordered or disordered arrangements of equal spheres.

Foraminifera

To British marine zoologists, more particularly those dealing with the North Sea area, Hans Högland's work on the foraminifera in the Gullmar Fjord and the Skagerak (*Zool. Bidrag f. Uppsala*, **26**; 1947) should prove very useful. While it includes only thirteen families of the Foraminifera it has reached formidable size, for in it are discussed in detail 133 species and varieties, and the remaining families are likely to contain nearly as many forms. It is fortunate that the author has had access to Gcēs' material, for it formed the basis of our knowledge of the Foraminifera in this area. Since the publication of Gcēs' work more than fifty years ago, a great deal has been done on this group with much alteration of classification and taxonomy. In classification, Högland has adopted a somewhat conservative attitude and has based his upon that of Cushman (1933), but he has been more drastic in the matter of nomenclature. Where the data appeared adequate the work has been carried out quantitatively, and here striking differences resulting from various collecting techniques are manifest. As an example, we have one form, *Bulimina fusiformis*, where the core sampler gave a total of 5,500 specimens and the corresponding sledge-net sample gave only thirty. It is interesting to note that the author was attracted to the study of this group from the ecological point of view, but soon realized that ecology must be based upon sound identification and taxonomy: hence the 32 splendid plates and the 303 figures which illustrate the range of variation within what the author regards as valid species.

Scientific Research in India

A REPORT has been issued, in the *Proceedings of the National Institute of Sciences of India* (**11**, Pt. 4, 161–370), of a symposium on the centralization of scientific research in India, held on July 23, 1945, which was opened by the president of the Institute, Mr. D. N. Wadia. Mr. Wadia, after referring to the necessity of taking into account the effect of a central policy on the work of various scientific institutions in India, emphasized the benefits likely to accrue from a central organisation for scientific research. Central direction should not involve too much interference or loss of independence in the pursuit of science. Dr. J. A. Dunn supported the liaison and co-ordination of research by a single member and department of a central government as the only course which could be wisely pursued, but he was not in favour of the whole of the country's research being brought under one department. He outlined a scheme for a central council for scientific and industrial research, with provincial and State councils, a committee of central scientific departments and other boards and committees as required. Dr. A. C. Ukil advocated the co-ordination of researches but without power of interference with the findings of the National Research Council, which should be the supreme central body to organise research throughout the country; no Government department, he said, should be allowed to maintain its separate research section, independent of the guidance of that Council.

Prof. J. N. Mukherjee also emphasized that the different units dealing with various aspects of research need not all be under one authority; centralization of scientific research should not mean centralized control under one government department. The autonomy of universities and other non-official institutions should not be circumscribed. Prof. M. N. Saha strongly supported Prof. Hill's scheme, as did Prof. P. C. Mahalanobis, with some warning on the danger of bureaucracy and departmentalism creeping in. He urged that the National Institute should press for the fullest possible association with the work of the proposed department of the learned societies, universities and scientific institutions. Prof. S. P. Agharkar thought that the real difficulties in India were encountered at the policy-making level. Dr. G. J. Fowler set forth points for and against centralization and urged the need for care lest organisation crippled individual initiative. Dr. Nazir Ahmad indicated some practical difficulties, but supported the co-ordination of research so as to avoid overlapping, to accelerate the pace of research and to use and to train talent to the best advantage. Dr. J. N. Roy considered that the National Institute of Sciences should concern itself solely with the availability of adequate funds for scientific research, and that the question of organisation was outside its sphere. A report of the symposium is being sent to all Departments of the Government of India with an expression of opinion from the fellows of the Institute as to the necessity of there being one Department of the Government of India concerned with the formulation of policy, determination of priority and administration of all funds earmarked for scientific research.

Radio and Electrical Research in Canada

THE National Research Council of Canada has announced the formation of a Radio and Electrical Engineering Division under Mr. B. G. Ballard. This new Division is a consolidation of work formerly carried on in the Division of Physics and Electrical Engineering, and has become necessary on account of the great expansion of research activities in the fields of electronics and electrical engineering consequent upon the advances in radio and related techniques during recent years. There are at present some 230 members of staff in the Division, including about fifty scientific personnel, and their work includes various aspects of radar, radio-physics, high-voltage electrical engineering, and the general application of electronics for military as well as for civil purposes.

Mr. Ballard, the new director of the Division, after graduating from Queen's University, Canada, obtained five years industrial experience with the Westinghouse Electric and Manufacturing Co. at East Pittsburgh. He joined the staff of the National Research Council in 1930, and has been engaged continuously in radio and electrical engineering research. His activities during the War were largely devoted to the development of mine-sweepers for enemy magnetic mines and the protection of ships against these mines; in recognition of his contributions in this field, Mr. Ballard was made an O.B.E. in 1946.

Lens-cleaning Tissues

USERS of optical instruments will be interested in details just issued by Messrs. J. Barcham Green, Ltd., the well-known makers of specialty hand-made papers, of their "105 Lens Tissue". It is claimed that this tissue has a particularly high strength, and yet is thin, light and almost fluff-free. It absorbs moisture and oil films readily, and special precautions are taken to exclude grit and similar impurities. Its bulking properties are evident from the fact that 500 sheets make a pack 1 in. thick and weigh less than 10 per cent of the weight of the same area of an ordinary writing paper. A 'near miss' from perfection is claimed; however, since (according to the leaflet) it has been possible to achieve the long-sought ideal of a *p*H value of 7·0, this claim must be regarded as modest, in one respect at least.

University College, Leicester: Appointments

THE Council of University College, Leicester, has announced the following appointments: Dr. A. G. Pool, senior lecturer in economics in the University of Sheffield, to the new chair of economics at the College; Dr. Z. P. Dienes, assistant lecturer in mathematics in the University of Manchester, to a lectureship in mathematics.

Physical Society's Exhibition

THE thirty-second Exhibition of Scientific Instruments and Apparatus, organised by the Physical Society, will be held during April 6–9 at the Imperial College of Science and Technology, London. Discourses will be delivered on three evenings at 6.45 p.m. as follows: Tuesday (April 6), "Studio Acoustics", by H. L. Kirke (British Broadcasting Corporation); Wednesday (April 7), "Low Temperature Physics", by Dr. K. Mendelssohn (Clarendon Laboratory, Oxford); Thursday (April 8), "The Reflecting Microscope", by Dr. C. R. Burch, W. J. Bates and Mr. K. W. Keohane (University of Bristol). Films will be shown on each of the four days: "Atomic Physics" (including Friday, April 9, at 6.45 p.m.); "Physics and the Film" by the British Kinematographic Society. The Exhibition will be open at the following times: April 6, 2 p.m.–9 p.m.; April 7–9, 10 a.m.–1 p.m., 2 p.m.–8 p.m. Admission is by ticket only. Catalogues are now available.

Announcements

M. CHARLES DUFRAISSE has been elected a member of the Paris Academy of Sciences in the Section of Chemistry, in succession to the late M. Robert Lespieau.

PROF. W. T. ASTBURY, professor of biomolecular structure in the University of Leeds, will give the Silvanus Thompson Memorial Lecture of the British Institute of Radiology on April 16 at 8 p.m. in the Reid-Knox Hall at 32 Welbeck Street, London, W.1. The title of his address will be "The Structure of Biological Tissues as Revealed by X-Ray Diffraction Analysis and Electron Microscopy".

LORD PORTAL OF HUNGERFORD, controller of production (atomic energy) in the Ministry of Supply, has completed his work for the production organisation and its relation with research, both at the Atomic Energy Research Establishment, Harwell, and elsewhere. He has agreed, however, to continue to act on a part-time basis, without salary, for another year.

A CONFERENCE on "The Human Factor in Industry" has been arranged by the British Association and will be held at Leamington Spa in the afternoon and evening of Saturday, May 8. Sir Henry Tizard, president of the Association and chairman of the Advisory Council on Scientific Policy, will preside at the first session, and Sir George Schuster, chairman of the Industrial Productivity Committee's Panel on Human Factors, will occupy the chair at the second. The conference will be open, without charge, to all who are interested. Further particulars will be available in due course by application to the Secretary, British Association, Burlington House, Piccadilly, W.1.

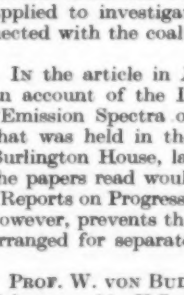
THE Botanical Society of the British Isles is holding a conference on "The Study of Critical British Groups" in the Royal Horticultural Society's New Hall, Westminster, S.W.1, during April 9–10. The meeting will be held under the presidency of Mr. J. S. L. Gilmour. Further particulars can be obtained from Miss M. S. Campbell, c/o Department of Botany, British Museum (Natural History), Cromwell Road, London, S.W.7.

THE Council of the Chemical Society will award grants from its research fund in June next. Applications, to be made on forms obtainable from the General Secretary, must be received on or before May 10. Applications from fellows of the Society will receive prior consideration. Attention is directed to the fact that the income arising from the donation of the Worshipful Company of Goldsmiths is principally devoted to the encouragement of research in inorganic and metallurgical chemistry, and that the income from the Perkin Memorial Fund is to be applied to investigations relating to problems connected with the coal tar and allied industries.

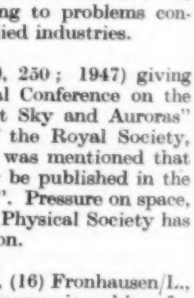
IN the article in *Nature* (**160**, 250; 1947) giving an account of the International Conference on the "Emission Spectra of the Night Sky and Auroras" that was held in the rooms of the Royal Society, Burlington House, last July, it was mentioned that the papers read would probably be published in the "Reports on Progress in Physics". Pressure on space, however, prevents this, and the Physical Society has arranged for separate publication.

PROF. W. VON BUDDENBROCK, (16) Fronhausen/L., Talstrasse 10, U.S. Zone, Germany, is asking for reprints of papers, to enable him to proceed with the preparation of vols. 3 and 4 of his "Grundriss der vergleichenden Physiologie". It is intended to translate the work into English.

ERRATA. Referring to the communication "The *C/D* Ring Union in Œstrone and Equilenin" in *Nature* of March 20, p. 434, Dr. W. Klyne states that formulæ V and VII should have been as follow and not as shown:



V. 13-*iso*, 14-*iso*



VII.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Electrical Conductivity of the Ionospheric *D*-Layer

RECENTLY, D. F. Martyn[1] has suggested that electric currents in the *D*-layer of the ionosphere must make a contribution to the solar and lunar geomagnetic variations roughly equal to that of the *E*- and *F*-layers. Since theoretical work on atmospheric tides suggests that the tidal motions tend to increase with height, the electric forces causing the currents can scarcely be greater in the *D*-layer than in the *E*- and *F*-layers. Hence Martyn's suggestion implies that the integral conductivity of the *D*-layer must be at least as big as that of the *E*- and *F*-layers combined. This appears to us to be improbable.

The integral conductivity of the *E*- and *F*-layers combined[2] is of order $2 \times 10^{-8} - 10^{-7}$ E.M.U. If electrons in the *D*-layer (taken to be at about 65 km.) were to produce an integral conductivity of this order, they would have to number several million per cm.^{3}. This is, of course, an impossibly high figure: to produce only a reasonable degree of attenuation in waves passing through the layer, only a few hundred electrons can be present per cm.^{3}.

If ions in the *D*-layer produced a similar conductivity, there would have to be at least 3×10^9 of them per cm.^{3}. This estimate, though large, is easily seen to be correct in order of magnitude; the ion conductivity, for a given number of ions, varies inversely as the gas-density between the *D*- and *E*-layers (that is, about in the ratio 1 : 1,000); the *D*-layer is narrower than *E*; and the *F*-layer possesses a larger conductivity than *E* unless negative ions are numerous in the latter. A density of 3×10^9 ions per cm.^{3} is difficult to reconcile with only a few hundred electrons per cm.^{3}; Massey and Bates' work on the *E*-layer[3] suggests that there can scarcely be as many as 1,000 negative ions per electron in the *D*-layer. Moreover, 3×10^9 ions per cm.^{3} are enough to reflect waves of wave-length 150 m., and to attenuate waves of wave-length greater than 35 m. to less than a tenth of their strength each time they pass through the *D*-layer. This, then, rules out the possibility of a layer of the required conductivity existing at the assumed height of the *D*-layer, that is, at about 65 km.

There remains the possibility that the conducting layer exists at a greater height, though still definitely below the *E*-layer. To get reasonable values for the attenuation of 200-m. waves the conducting layer must be at a height of more than 80 km.; if in addition the ratio of the numbers of negative ions and electrons is not to exceed 1,000 : 1, the layer must be at least at a height of 95–100 km. Such a height is not far from that of the *E*-layer, and since there are likely to be far fewer than 1,000 negative ions per electron at this level, even this height is likely to be an under-estimate. It appears, therefore, that a layer of the required conductivity can scarcely exist below the *E*-layer.

T. G. COWLING
R. BORGER

University College, Bangor.
Dec. 23.

[1] Martyn, *Nature*, **160**, 535 (1947).
[2] Cowling, *Proc. Roy. Soc.*, A, **183**, 453 (1945).
[3] Massey and Bates, *Rep. Prog. Phys.*, **8**, 62 (1942).

Frequency Variation of the Intensity of Cosmic Radio Noise

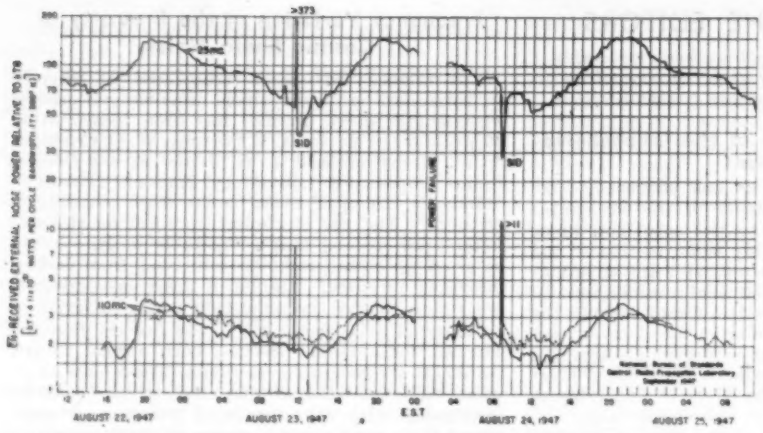
THE intensity of cosmic radio noise (as received on horizontal half-wave dipole antennæ one quarter wave-length above ground) has been measured at 25 Mc. and 110 Mc. by H. V. Cottony, W. Q. Crichlow, J. W. Herbstreit and J. R. Johler at the Central Radio Propagation Laboratory, National Bureau of Standards, using identical noise diode calibration methods. The use of similar antennæ on the two frequencies ensured that comparable weights would be given the cosmic radio noise arriving from various directions in space. Results of these measurements are shown in the accompanying graph in terms of an external noise factor $\overline{EN}$[1]. Results are given on 110 Mc. for antennæ oriented both normal to and parallel to the geographic meridian. These have somewhat different diurnal patterns which compare favourably with the calculated patterns obtained when the cosmic radio noise intensity contours obtained by Reber[2], using highly directional antennæ, are appropriately integrated over the two broad directivity patterns of the dipole antennæ.

After allowing for the portion of the external noise energy radiated from the ground at an assumed temperature of 300° K., and on the assumption that the effective temperature of outer space (weighted in various directions by the dipole directivity) varies in accordance with some power of the frequency, the following expressions have been derived from these measurements for the maximum and minimum external cosmic radio noise factors corresponding to reception at this latitude on half-wave antennæ, one quarter wave-length above a perfectly reflecting ground:

$$\overline{EN}' = 4{\cdot}40 \times 10^5 f_{\text{Mc.}}^{-2{\cdot}41} \text{ maximum;}$$
$$\overline{EN}' = 1{\cdot}58 \times 10^5 f_{\text{Mc.}}^{-2{\cdot}41} \text{ minimum.}$$

Since the effect of absorption in the earth's ionosphere would be expected to be negligible on both 25 and 110 Mc. at night and on 110 Mc. both day and night, the exponent in the above two expressions was derived from the averages of the maximum values for the three nights, while the ratio of maximum to minimum noise was determined from the 110-Mc. measurements. The above expressions having been obtained in such a way as to minimize the effects of both ground and ionospheric absorption, they provide a direct measure of the variation of the mean cosmic radio noise arriving from outer space as a function of frequency. Thus this incident noise is seen to be proportional to $f_{\text{Mc.}}^{-2{\cdot}41}$, after allowance is made for the frequency-squared factor arising from the relative absorbing areas of the two antennæ. The absolute accuracy of the measurements on both frequencies is such that the first significant figure in the above exponent is considered to be accurate while the second is doubtful.

Also shown in these measurements is the occurrence of several short-time bursts of very strong noise radiation which occurred at times when sudden ionosphere disturbances were reported[3]. During the first of these, a burst of radio noise presumably of solar origin occurred on both 25 and 110 Mc. at the onset, followed, on 25 Mc. only, by a period of extraordinarily reduced external noise. In the second, the sudden ionospheric disturbance and reduced external noise on 25 Mc. commenced approximately 7½ min.



EXTERNAL NOISE RECEIVED ON HORIZONTAL HALF-WAVE DIPOLES A QUARTER WAVE-LENGTH ABOVE GROUND, AT STERLING, VA., LAT. 38° 59′ N., LONG. 77° 28′ W.

Approximate characteristics, $\sigma = 2 \times 10^{-14}$, $\varepsilon = 4$. Full line, dipole in east–west plane; broken line, dipole in north–south plane. *SID*, sudden ionospheric disturbances

before the radio noise burst, similar to the phenomena described by Hey, Parsons and Phillips[4].

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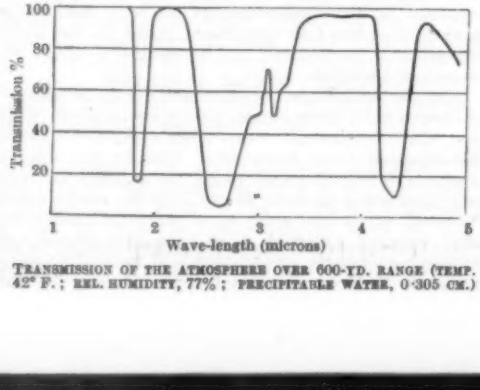
JOSEPH R. JOHLER
Experimental Ionospheric Research Section,
Central Radio Propagation Laboratory,
National Bureau of Standards,
Washington.
Nov. 10.

[1] Norton, K. A., and Omberg, A. C., *Proc. Inst. Rad. Eng.*, **35**, 4 (1947).
[2] Reber, G., *Astrophys. J.*, **100**, 279 (1944).
[3] Central Radio Propagation Laboratory, National Bureau of Standards, Ionospheric Data, CRPL-F37 (September 1947).
[4] Hey, J. S., Parsons, S. J., and Phillips, J. W. *Nature*, **160**, 371 (1947).

Transmission of the Atmosphere in the 1–5 Micron Region

THE most comprehensive published data available for the transmission of the atmosphere in the infra-red region is that of Fowle[1], whose results were obtained over comparatively short paths (maximum 127 yards) in the laboratory. In spite of the short path, no region clear of considerable absorption was reported between 2·1 and 8·5 microns. It may be of interest to record preliminary field results obtained during work at this Laboratory in the 1–5 micron region using the greatly improved apparatus now available.



TRANSMISSION OF THE ATMOSPHERE OVER 600-YD. RANGE (TEMP. 42° F.; REL. HUMIDITY, 77%; PRECIPITABLE WATER, 0·305 CM.)

The measurements were made using a source and spectrometer separated by a 600-yard range. The source consisted of a Nernst filament at the focus of a 2-ft. focal-length parabolic mirror of 2-ft. diameter. A mirror system of 10-ft. focal-length served as collector unit for the spectrometer. The latter was a Littrow arrangement with a 30° rocksalt prism. A Hilger–Schwarz thermopile was used as detector in conjunction with a General Motors D.C. amplifier[2]. Amplifier output was displayed on an Evershed and Vignoles 5-mA. double-pen recorder, one pen of which was used for wave-length calibration marks. To obtain the transmission curve, comparison was made between emission curves of the Nernst filament obtained over a short range (5 ft.) and over the 600-yd. range. In calculating percentage transmission, it was assumed that the value at 2·2 microns was 100 per cent[1].

A typical curve is reproduced herewith. It will be seen that, in particular, a region of high transmission exists between 3 and 4 microns. Fowle's figure for 3·5 microns is about 65 per cent transmission (127 yards). Our results were obtained in what was intended to be only a preliminary investigation; but they are considered quite adequate to show that transmission in the 3·5-micron region is comparable with that at 2·2 microns.

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Dec. 29.

* Now at Courtaulds, Ltd., Maidenhead, Berkshire.

[1] Fowle, F. E., Smithsonian Misc. Coll., **68**, No. 8 (1917).
[2] Liston, M. D., Quinn, C. E., Sargeant, W. E., and Scott, G. G., *Rev. Sci. Instr.*, **17**, 194 (1946).

Spin-Dependence of Magnetic Dipole Gamma Radiation and the Nuclear Level Scheme of Pb^{203}

Hulme, Mott, Oppenheimer and Taylor[1] remarked that a γ-ray due to a transition between levels of the same parity may be a mixture of magnetic dipole and electric quadripole radiations. This is possible when the change ΔI in the quantum number I for the total nuclear spin is ± 1 or 0. The relative proportions in the mixture will depend on the structure of the nucleus. For $\Delta I = \pm 2$, no parity change, magnetic dipole radiation is forbidden and nearly pure electric quadripole radiation will be emitted. An exception occurs if the spin change is $1 \leftrightarrow 0$, when the radiation must be pure magnetic dipole.

The presence of a high proportion of magnetic dipole radiation will give an abnormally large coefficient α_K of internal conversion in the K-shell.

α_K may approach the value for pure magnetic dipole radiation, which is roughly three times that for pure electric quadripole radiation of the same quantum energy $h\nu$, if less than 0·5 MeV.

The classification of γ-rays by the proportion of magnetic dipole radiation may prove useful in assigning quantum numbers I to the upper levels of nuclei when estimates of α_K are available.

In the case of Pb^{208}, it is clear from the photo-electron spectrum of Thibaud[2] that the M γ-ray of ThC″ → Pb of 582 ekV. has an intensity about three times that of the L γ-ray of 510 ekV., and yet their internal conversion lines have similar strengths. Measurements made with D. G. E. Martin[3] have shown that for both the L and the G rays (277 ekV.) α_K is near the theoretical value for pure magnetic dipole radiation, whereas for the M γ-ray it is much lower and in rough agreement with the pure electric quadripole value.

The contrast is striking and can scarcely be due to the highly converted G and L rays arising from $1 \leftrightarrow 0$ transitions.

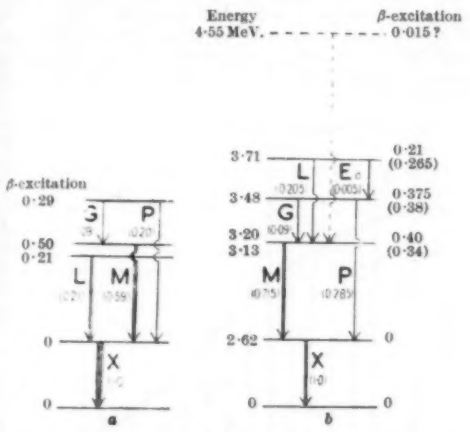

Fig. 1. LEVEL SCHEMES FOR Pb^{208} SHOWING THE NUMBER OF TRANSITIONS PER DISINTEGRATION OF THE MAIN γ-RAYS

In Fig. 1 are two level schemes for Pb^{208} (thorium D) compatible with the uncertain evidence on the γ-ray intensities which, for the P ray (859 ekV.), are taken from the data of Johansson[4]. A decision between the two schemes may be based on further evidence provided by the shape and end-point of the nuclear β-spectrum of ThC″ → D.

We can calculate the end-points of the partial β-spectra which should excite the levels in Fig. 1 if we take the energy difference between the ground-states of ThC″ and Pb^{208} to be 4·995 MeV., from the known α-ray energies and the value 2·2505 MeV. for the β-ray energy of ThC→C′. For the 3·204 MeV. level, for example, the β end-point is at 1·791 MeV.

Using these end-points, we get the theoretical composite β-spectra in Fig. 2. Curve (1) is for scheme (*a*), and curves (2) and (3) are for (*b*), omitting the β-spectrum to the 4·55 MeV.-level. In curve (3) the G and L γ-rays are given higher intensities of 0·10 and 0·26, with the β-excitations shown in brackets. The ordinates N/N_1 give the ratio of the number of β-rays between ε and $\varepsilon + d\varepsilon$ to the number for a single allowed transition with end-point at 1·791 MeV. The small circles are the experimental points of

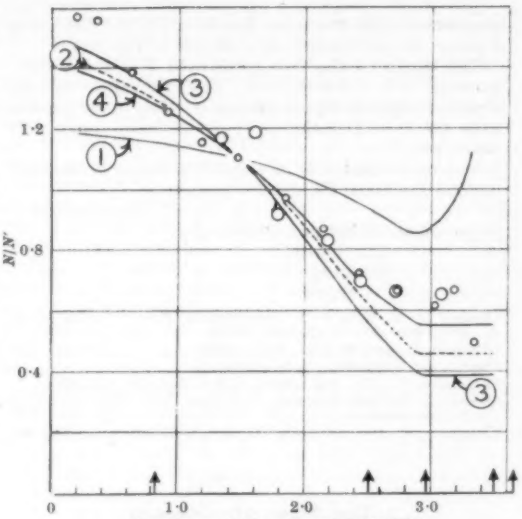

Fig. 2. β-SPECTRUM OF THORIUM C″ → D. THE ARROWS INDICATE β-END-POINTS ON THE LEVELS IN FIG. 1. CURVE 4 DIFFERS FROM CURVE 2 IN USING INTENSITIES 0·80 AND 0·20 FOR THE M AND P γ-RAYS

Martin, Richardson and Hsü[5], and the large ones those of Siegbahn and Johansson[6], obtained with an α-ray recoil source.

Curve (1), with end-point at 1·864 MeV., predicts too many high-energy β-rays. The experiments agree fairly well with curves (2) and (3), except below 0·4 MeV., where a surplus of low-energy β-rays is found. This may be due to a partial β-spectrum exciting one or more levels of Pb^{208} at about 4·55 MeV., as shown by the broken line in Fig. 1. The resulting weak γ-rays of intensity about 0·03 per disintegration have not been identified with certainty, but all the other rays allowed by the selection rules in scheme (*b*) have been found.

The levels should all have the same parity because the observed values of α_K are too large for electric dipole γ-rays. The parity should presumably be even because Pb^{208} is an even-even nucleus with $I = 0$ in the ground-state. It follows that if the β-transition to any one of these levels is allowed, the β-transitions to the others must be either allowed or second or fourth forbidden to avoid a change of parity.

For scheme (*b*) the values of I for the upper levels can then be deduced under the following conditions. (*a*) the G and L γ-rays have $\Delta I = 0$ or ± 1, and the M ray has $\Delta I = \pm 2$; (*b*) the β-transitions to the higher levels are allowed with $\Delta I = 0$ or ± 1 and no parity change; (*c*) the β-transition from ThC″ to the ground-state of Pb^{208} is fourth forbidden and that to the 2·62 MeV. level is second forbidden. These conditions restrict I for the ground-state of ThC″ to be either 5 or 4.

Nucleus	ThC″	Pb^{208}					
Energy of level (MeV.)	0	0	2·62	3·20	3·48	3·71	4·55
Possible set of values of I	5 4 4	0 0 0	2 1 2	4 3 4	4 3 3 or 4	5 4 5	4, 5 or 6 3, 4 or 5 3, 4 or 5

The value 5 leads to a unique set of spin quantum numbers for the five lower levels of Pb^{208}. The value 4 gives the alternative sets shown in the table.

The upper of the two rows with $I = 4$ for ThC″ gives $\Delta I = -1$ for the 2·62 MeV. ray, thus making it pure magnetic dipole radiation. The other choices with $\Delta I = -2$ make it pure electric quadripole radiation.

The term scheme is incomplete because it does not include the weak *Ec* and *Fb* γ-rays.

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The Mass of σ-Mesons

The existence of mesons of different masses has been demonstrated by the recent exhaustive papers of Dr. C. F. Powell and his colleagues. We have recently carried out an investigation of the mass of the σ-mesons, that is, those mesons which produce disintegrations in nuclei.

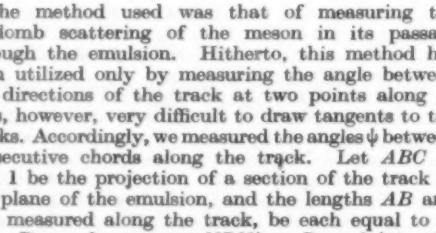

Fig. 1

The method used was that of measuring the Coulomb scattering of the meson in its passage through the emulsion. Hitherto, this method has been utilized only by measuring the angle between the directions of the track at two points along it. It is, however, very difficult to draw tangents to the tracks. Accordingly, we measured the angles ψ between consecutive chords along the track. Let *ABC* in Fig. 1 be the projection of a section of the track in the plane of the emulsion, and the lengths *AB* and *BC*, measured along the track, be each equal to x, say. Draw the tangent *NBN′* at *B*, and join *AB* and *BC*; then the angle between the chords is equal to $(\varphi_1 \pm \varphi_2)$;

$$\therefore (\psi^2)_{av} = (\varphi_1^2)_{av} + (\varphi_2^2)_{av}.$$

Draw perpendiculars *AN*, *CN′*, of lengths y_1 and y_2 respectively, to *NBN′*; then

$$\varphi_1 = y_1/x \text{ and } \varphi_2 = y_2/x.$$

Hence $(\varphi_1^2)_{av} = (y_1^2)_{av}/x^2$ and $(\varphi_2^2)_{av} = (y_2^2)_{av}/x^2$.

If the angle between the tangents at *A* and *B* is θ_1, and that between the tangents at *B* and *C* is θ_2, it can be shown that

$$(y_1^2)_{av} = \tfrac{1}{3}x^2\,(\theta_1^2)_{av} \text{ and}$$
$$(y_2^2)_{av} = \tfrac{1}{3}x^2\,(\theta_2^2)_{av}$$
$$\therefore (\psi^2)_{av} = \tfrac{1}{3}\,((\theta_1^2)_{av} + (\theta_2^2)_{av}),$$

and $(\theta^2)_{av}$ can be calculated from the formula

$$(\theta^2)_{av} = \frac{4\pi e^4 Z^2 N x}{p^2 v^2} \log\left(\frac{\theta_{max}}{\theta_{min}}\right),$$

where

$$\theta_{min} = \left(\frac{mc}{p}\right)\left(\frac{Z^{1/3}}{181}\right),$$

and θ_{max} is the smallest angle that is recognizable as a single deflexion, Z, N, p and v have their usual meanings.

The advantages of this method are that the chords are easy to draw, and the observations repeatable. The only other method of measuring mass at present is by grain counts along the track, and owing to latent image fading this is not reliable. Also, multiple scattering gives a higher mass resolution for low masses than does grain counting.

We have observed, at the time of writing, some thirty σ-meson tracks, of which fifteen were long enough to investigate. These were traced on the screen of a projection microscope, using a magnification of about 1,500 ×, and divided into twenty μ sections, and the angles between the chords measured. The theoretical values of $(\psi^2)_{av}$ at various distances along the tracks of mesons of mass 200, 360 and 900 electron masses, as well as those for protons, were calculated. It was found that if $(\psi^2)_{av}$ was plotted against range from end of track, the forms of the curves were very similar.

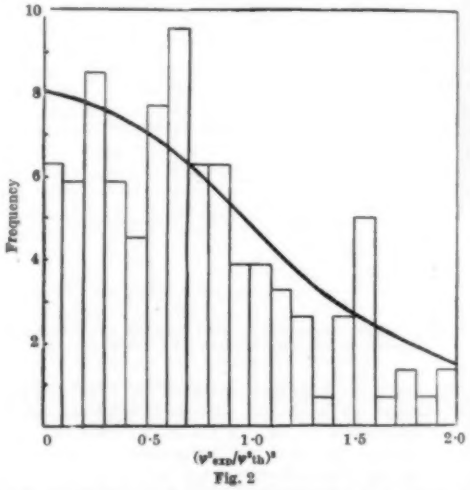

Fig. 2

Therefore, to interpret the results, the values of ψ^2 obtained experimentally at any point were divided by the theoretical value of $(\psi^2)_{av}$ at the same distance from the end of the track, for a meson of mass 300. A histogram (Fig. 2) was plotted of the square root of these quotients against frequency, for all quotients from all tracks. It can be shown that the distribution of multiple scattering angle is Gaussian, and it follows that the distribution of this quotient is also Gaussian, assuming that the mass is always the same. From this it was found that the mass was in the neighbourhood of 300 electron masses. The curve for this mass is shown in Fig. 2. It was also found, however, that the distribution obtained could equally well be explained by assuming mesons of different masses; but the results show that the mesons are not all of mass 200 electron masses. The value of 290 for the mass was also obtained by taking the mean of the

values of ψ^2 obtained from the different tracks, at the same distance from the end, and finding the corresponding mass. This was done for all distances, and the mean of the mass values thus obtained taken.

This method would seem to be capable of giving a good estimate of the mean mass of a number of particles; but would be unable to resolve the masses into distinct groups, if such groups occurred. We can, however, say that if any appreciable number of the σ-mesons have mass 200, there must be a corresponding number with mass greater than about 400, and the mean mass is 290 ± 80 electron masses.

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A Method of Feeding Micro-wave Power into a Resonator having a Fine Mode Structure

IN the course of investigations into the design of a micro-wave linear accelerator of the resonant type, to operate at 3,000 mc./s. (cf. Fry[1]), we have succeeded in feeding power into a 24-cavity evacuated resonator 120 cm. long, having a separation in frequency of only 0·2 per cent (that is, 6 Mc./s.) between the required mode of operation and the adjacent mode. The required mode had a phase difference of π between currents in adjacent cavities.

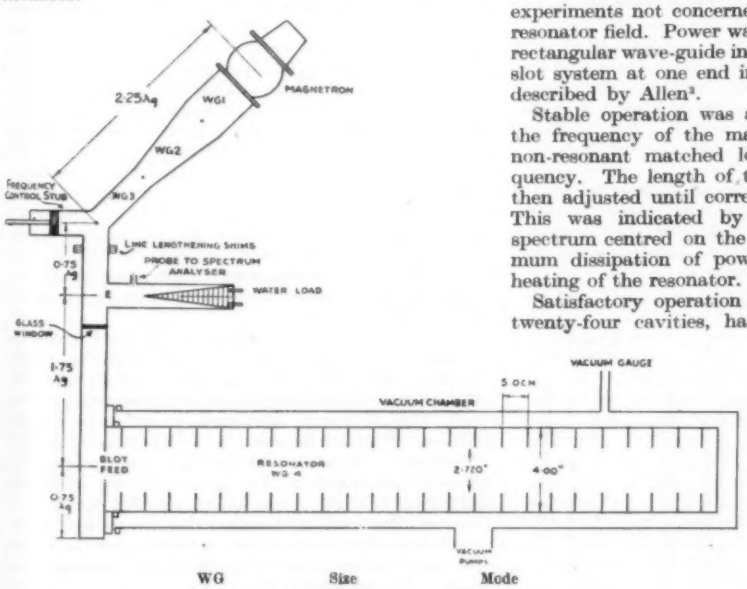
The micro-wave power was generated by an experimental pulsed magnetron, type *E* 1944, driven at 500 p.p.s. with 2 μsec. pulses by a standard Admiralty type 277 modulator, loaned by the Admiralty Signal Establishment. This modulator had a peak power output of 1·25 MW., and an estimated peak power of 390 kW. was fed into the resonator.

The circuit arrangement is shown in the diagram. The resonator was coupled to the feeding wave-guide in such a way that it was equivalent to a series resonant circuit in parallel with the wave-guide at its point of connexion. The resonant resistance of this was 1/1·2 times the guide characteristic resistance (Z_0). In order to achieve frequency stability in the steady-state condition of oscillation, the effective length of wave-guide between the valve and the resonator was 4·75 guide wave-lengths. The combination of wave-guide and resonator measured at the valve was thus equivalent to a parallel resonant circuit the resistance of which at resonance was $1{\cdot}2\,Z_0$. In order to achieve stability during the resonator build-up time, a resistance of the water-load type was placed in series with the wave-guide[2] at such a point that in the steady-state condition it was effectively in series with the resonator, when measured at the valve, and had a resistance of $0{\cdot}6\,Z_0$. Consequently, 65 per cent of the generated power was absorbed by the resonator. The magnetron used had a frequency pulling figure of 15 Mc./s., so that in the steady state, with an effective load impedance of $1{\cdot}8\,Z_0$ due to the resonator and the stabilizing resistance, its electronic efficiency was reduced from 50 per cent to 45 per cent[3]. The power absorbed by the resonator was thus 60 per cent of the power output of the valve when feeding a matched load. The peak power output when feeding into a non-resonant matched load was 650 kW.; hence the estimated peak power fed into the resonator was 390 kW.

The resonator consisted of a circular wave-guide of 4 in. internal diameter having twenty-four circular irises of diameter 2·720 in. spaced 5 cm. between centres (that is, half the operating wave-length) and closed at both ends by walls spaced 2·5 cm. from the centre of the end irises. The measured Q factor was 8,000, the internal finish being poor; but this factor was considered relatively unimportant for initial experiments not concerned with the strength of the resonator field. Power was fed from the 3 in. × 1 in. rectangular wave-guide into the resonator by a double slot system at one end in a similar manner to that described by Allen[3].

Stable operation was achieved by first adjusting the frequency of the magnetron, operating with a non-resonant matched load, to the resonator frequency. The length of the feeding wave-guide was then adjusted until correct operation was obtained. This was indicated by a very stable frequency spectrum centred on the resonator frequency, minimum dissipation of power in the water load and heating of the resonator.

Satisfactory operation was readily achieved with twenty-four cavities, having an overall length of 120 cm., with a frequency difference between adjacent modes of 0·2 per cent. This frequency difference is theoretically proportional to the inverse square of the number of cavities. From the range of magnetron tuning over which stable operation occurred it is anticipated that a considerably longer resonator, with a correspondingly finer mode structure, can be



satisfactorily fed in the required mode by this method.

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Fission Products of U^{233}

EXPERIMENTS have been described[1,2] which give data for the fission products of U^{235} produced in thermal neutron irradiation of natural uranium. Recently, a new radioactive series, not present in Nature, has been reported[3,4]. Seaborg has shown that U^{233}, a member of this series, is fissile with neutrons. The following is a summary of the results of a survey of the longer-lived fission products of U^{233}. The data were obtained in conjunction with those previously reported[1], but could not be released for publication at that time.

The relative yields of the fission products are given directly by the equilibrium activities for an infinitely long bombardment at a constant rate. The yield of Ba^{140} from the fission of U^{235} in natural uranium is taken as a reference. Three samples were irradiated simultaneously, one U^{233} and two natural uranium samples. In order to facilitate direct comparison of the fission-product activities in the natural uranium and U^{233} samples, the weights of the respective samples used were such that the number of fissions produced in each were equal.

After irradiation, a chemical separation of each element lying between arsenic and praseodymium was made. Thirty-one active isotopes were found and identified by their half-lives and their β-, γ-ray absorption characteristics. In all cases, identical activities were observed in the natural and U^{233} samples.

The fission yields for U^{233} are presented in the accompanying table together with those for U^{235}. As with U^{235}, a plot of fission yield against mass number shows a double-humped curve indicating a light group and a heavy group.

FISSION YIELDS FOR U^{233} AND U^{235}

Mass number	U^{235}	U^{233}	Active isotope determined
89	$3{\cdot}2 \times 10^{-2}$	$4{\cdot}1 \times 10^{-2}$	55 d Sr
90	$4{\cdot}0 \times 10^{-2}$	$3{\cdot}7 \times 10^{-2}$	~30 y Sr
91	$4{\cdot}0 \times 10^{-2}$	$4{\cdot}1 \times 10^{-2}$	61 d Y
95	$3{\cdot}2 \times 10^{-2}$	$3{\cdot}9 \times 10^{-2}$	65 d Zr
103	$8{\cdot}4 \times 10^{-3}$	$2{\cdot}1 \times 10^{-2}$	37 d Ru
106	$1{\cdot}5 \times 10^{-2}$	$6{\cdot}4 \times 10^{-4}$	290 d Ru
111	$1{\cdot}6 \times 10^{-3}$	$1{\cdot}5 \times 10^{-4}$	7·5 d Ag
(123)	$6{\cdot}4 \times 10^{-3}$	$1{\cdot}9 \times 10^{-3}$	~18 d Sn
(123)	$8{\cdot}5 \times 10^{-3}$	$2{\cdot}5 \times 10^{-3}$	136 d Sn
127	$1{\cdot}5 \times 10^{-3}$	$6{\cdot}7 \times 10^{-4}$	90 d Te
125	$8{\cdot}9 \times 10^{-3}$	$6{\cdot}0 \times 10^{-4}$	~10 y Sb
129	$9{\cdot}0 \times 10^{-4}$	$2{\cdot}2 \times 10^{-3}$	32 d Te
131	$1{\cdot}5 \times 10^{-3}$	$2{\cdot}4 \times 10^{-3}$	8·1 d I
132	$4{\cdot}9 \times 10^{-3}$	$4{\cdot}9 \times 10^{-3}$	2·3 h I
137	$1{\cdot}8 \times 10^{-3}$	$1{\cdot}8 \times 10^{-3}$	33 y Cs
(136)	$\sim 10^{-4}$	$\sim 10^{-4}$	~20 d Cs
140	$5{\cdot}6 \times 10^{-3}$	$6{\cdot}7 \times 10^{-3}$	40 h La
144	$2{\cdot}9 \times 10^{-3}$	$2{\cdot}2 \times 10^{-3}$	290 d Ce
147	$\sim 6 \times 10^{-3}$	$\sim 6 \times 10^{-3}$	~4 y 61

In U^{233} fission the groups have a similar shape to those for U^{235} but are one unit lower on the mass scale. The maxima of the fission-yield curves are approximately the same in all cases, being approximately 6×10^{-2}.

A detailed account of the investigation is to be published.

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Fluorescence of Highly Insulating Dielectrics Produced by X- and γ-Radiations

IN the course of experiments designed to study photographically the secondary electron emission from various light-atom materials when they are irradiated with high-voltage X-rays, we have found that under certain radiation conditions some highly insulating dielectrics fluoresce when so irradiated, visible and possibly ultra-violet light being emitted. Polystyrene in the commercial form known as 'Distrene' shows the phenomenon quite markedly.

In our first experiments, using X-rays generated at 200 kVp. (half-value layer, 2 mm. copper), the photographic blackening due to secondary electronic emission[1,2,3] was being examined for a range of light-atom materials which included amber, 'Perspex', paraffin wax, 'Alkathene' and 'Distrene', and for such elements as carbon, sulphur, aluminium, copper, silver, tin, gold and lead. The density of blackening obtained for the light-atom materials was much as one would theoretically expect with the exception of 'Distrene'; for this material the density was almost as great as that for copper. Various samples were used with always the same result. It was suggested by Dr. F. W. Spiers that the extra unexpected density might be due to fluorescent radiation, and this is so. A single layer of black paper was found to absorb the radiation and reduce the density of blackening to expected values; the transmission through various thicknesses of glass suggested that some of the radiation might be ultra-violet as well as visible.

The same light-atom materials were examined visually in the dark while they were irradiated with X-rays. No definite fluorescence could be seen from amber, only a faint suggestion was seen from paraffin wax, 'Perspex', and 'Alkathene'; but quite a strong diffuse whitish fluorescence was observed from 'Distrene'. Similar observations were made using X-rays generated at 110 kVp. and 60 kVp. No apparent afterglow was seen; as the X-ray beam was switched off so the fluorescence disappeared.

Similar experiments were made in the dark using the gamma-ray beam from a 2-gm. radium mass unit[4]. In this case a feeble fluorescence of a similar colour was seen from amber and 'Perspex' and quite a strong fluorescence from paraffin wax, 'Alkathene' and 'Distrene'. This fluorescence was also detectable

photographically for paraffin wax as well as 'Distrene', but nothing could be detected from 'Perspex' by this means. Again no apparent afterglow could be seen even when the materials were left in the gamma-ray beam for a whole week-end.

Mallet[5] referred to the fluorescence under γ-irradiation of some fluids, including water, grease, oil, albumin and blood serum, and Newcomer[6], in a paper dealing with the fluorescence under X-irradiation of some five hundred compounds, mostly organic, refers to the fluorescence of his paraffined paper cups as being barely within the limits of visibility.

The fluorescence observed in 'Distrene' may be related to the observation by Farmer[7] that, after receiving a considerable dose of X-rays, the insulating properties of 'Distrene' are impaired. Slight traces of impurities are known to be sometimes responsible for fluorescence in many substances, and it is likely that something of this nature may be the responsible agent in this case. If this is so, their removal might conceivably eliminate the phenomenon and improve the insulating properties of 'Distrene' under X-irradiation.

A use of this property of 'Distrene' which suggests itself is as an intensifying screen for certain purposes. If photographic response to X-rays could be made independent of wave-length, such response could be used for measuring X-ray dose and dose distribution. Independence of wave-length might be more nearly realized by the use of suitable intensifying screens; but a difficulty, particularly for phantom measurements, is absorption in the screens. Sheet 'Distrene' would act as a light-atom intensifying screen which would possibly eliminate absorption difficulties and might lead to the required wave-length independence.

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Transition from Glow to Arc Discharge

I HAVE suggested[1] a mechanism to account for the occurrence of long electrical discharges in electric fields which are only of the order of one per cent of those generally believed[2,3] necessary to cause sparkover. In the case of the leader stroke of the lightning discharge, the integrated lateral corona currents from the channel ultimately reach values of the order of thousands of amperes[4], so that the characteristics of the channel must be those of the electric arc, though the discharge must start as a brush or glow discharge. This consideration led me to suggest that the steps in the initial leader stroke represent the transition of successive lengths of the channel from glow to arc conditions, and that a self-propagating discharge is initiated by this transition.

It has been contended[5], in criticism of this view, that the phenomenon of glow to arc transition is entirely governed by the conditions at the cathode,

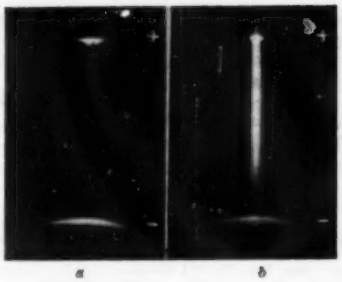

Fig. 1. STROBOSCOPIC PHOTOGRAPHS OF 1 CM. A.C. DISCHARGE IN HYDROGEN. (*a*) 0·9 AMP.; (*b*) 1·6 AMP. ACTUAL EXPOSURE TIMES, 2 SEC. AND 1 SEC. RESPECTIVELY

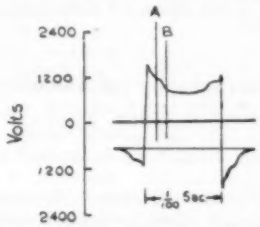

Fig. 2. OSCILLOGRAM OF VOLTAGE ACROSS DISCHARGE. PHOTOGRAPHS OF FIG. 1 TAKEN AT *A* AND *B*

and not at all by those in the discharge column. Experiments in these laboratories have, however, shown that a clearly discernible transition, of the nature usually described as that of glow to arc, occurs in a discharge, which is certainly independent of conditions at the cathode.

Fig. 1 shows two stroboscopic photographs taken before and after this transition has occurred in an alternating current discharge between water-cooled copper electrodes 1 cm. apart in hydrogen at atmospheric pressure, the peak current being 2 amp. At about 35 electrical degrees after current zero, that is, at a current of about 1·2 amp., the discharge column begins in the region of the anode to change from a diffuse glow to the narrow, bright, crimson column of the hydrogen arc. By the time the current reaches 1·5 amp. this condition has spread along the column to the vicinity of the cathode, which last, however, remains covered by the characteristic wide-spread glow of the glow discharge throughout. The cathode fall of potential likewise remains constant throughout at about 350 volts, whereas the potential gradient along the column falls from about 650 V./cm. in the glow phase to 350 V./cm. in the arc phase. Thus two interesting discharge conditions would appear to have been obtained, namely, a discharge with the column in the arc state while glow conditions persist at the cathode, and one in which the transition occurs in the discharge column itself.

The transition from glow to arc is dependent on the gas pressure as well as on the current in the discharge. In particular it has been observed by several investigators[6] that it does not occur at all below a gas pressure of the order of one hundredth of an atmosphere. This is just about the pressure at the surface of the solar photosphere, and, on a theory I have advanced[7], the latter surface is the result of the occurrence of this transition. Conversely, this agreement supports the view that the transition is a phenomenon primarily of the column and not of the electrode surface.

A fuller account of this work and its application to the spark discharge will appear in due course. I am indebted to my colleague, L. A. King, for much of the experimental work.

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Photography on Selenium

IT was observed many years ago that the crystallization of amorphous selenium is promoted and accelerated by illumination[1,2]. I rediscovered this in the summer of 1941 and succeeded in producing true photographic images by means of this effect, using the initial product of selenium manufacture, namely, aluminium or steel disks covered with a film of selenium, as photosensitive plates. To do this, the mirror-like surface of the selenium must be polished with a soft material, such as tissue paper. The disk is then placed on a metal plate, preheated at 90–95° C., and an image, preferably a diapositive, projected on the surface of the selenium. During exposure, 'self-development' takes place and in 1–2 minutes a somewhat faint but in other respects perfect image will appear. The photographic process is then complete and the disk can be removed from the hot plate.

The image is produced by progressive crystallization of the amorphous selenium. It causes the selenium surface to lose its lustre, to become velvet-like in texture, diffusing the light and changing its colour from black to grey, gradually and in proportion to the intensity of the incident light, that is, with the brightness of the different parts of the projected image. In consequence of this the copy of a positive image will be also a positive. Over-exposure rapidly deteriorates the image and turns it finally into a roughly crystalline uniform surface of grey colour.

The 'trick' of polishing (that is, covering the surface with very fine scratches) is of decisive importance: it facilitates the crystallization and makes this capricious process uniform and regular. Pure selenium crystallizes slowly: the selenium we used was mixed with 0·07 per cent iodine; increasing the iodine content would probably be advantageous.

Another method of 'selenography'—also in connexion with rectifier manufacture—is based upon my observation that the imperfectly reflecting black surface (at 100–120° C.) of hot-pressed, crystalline selenium changes to a light grey-coloured one; this takes place in the usual second heat treatment at about 210° C., and is also promoted by illumination.

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Collision Broadening of the Ammonia Inversion Spectrum at High Pressures

THE collision broadening of the inversion spectrum of ammonia has been studied by Bleaney and Penrose[1] at pressures up to 600 mm. mercury. The line-widths, measured at a pressure of 0·5 mm. mercury, give values for the collision diameters (for self-broadening) varying between 8·7 A. and 14·2 A., with a mean value (weighted according to the line strengths) of 13·2 A. Between 0·5 mm. and 100 mm. pressure, the shape of the absorption curve agrees closely with that calculated from the intensity and position of the individual lines, assuming that their widths vary linearly with the pressure. At 600 mm. pressure, however, the absorption maximum has shifted to less than 0·6 cm.$^{-1}$, and the curve shape is no longer consistent with that calculated from the structure factor of Van Vleck and Weisskopf[2], and Fröhlich[3], using the extrapolated line-widths.

These measurements have been extended to delineate the absorption curve in ammonia gas over the frequency-range 0·1–1·2 cm.$^{-1}$ at pressures up to six atmospheres. The absorption was determined from the damping of a resonator caused by the admission of the gas, by a technique similar to that of Bleaney and Penrose[4]. A cavity resonant in the H_1 mode was used, however, in order to avoid errors due to the tails of other resonances, which can occur in an H_0 cavity when filling it with a fluid of appreciable dielectric constant (see Bleaney, Loubser and Penrose[5]).

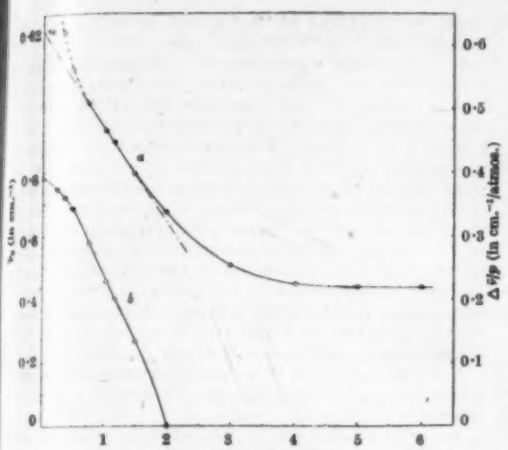
At high pressures the widths of the individual lines of the ammonia spectrum become large compared with their separation, and it should be possible to represent the observed line by the formula

$$\frac{\alpha}{\bar{\nu}^2} = \frac{4\pi^2}{3kT} \sum_{J,K} N_{J,K} |\mu_{J,K}|^2 \left\{ \frac{\Delta\bar{\nu}}{\Delta\bar{\nu}^2 + (\bar{\nu}_0 - \bar{\nu})^2} + \frac{\Delta\nu}{\Delta\bar{\nu}^2 + (\bar{\nu}_0 + \bar{\nu})^2} \right\}. \quad (1)$$

The whole resonance curve is thus treated as if due to a single line of resonant frequency $\bar{\nu}_0$, with a line-breadth constant $\Delta\bar{\nu}$, and an intensity corresponding to the sum of the intensities of the individual lines. It is found that above 10 cm. pressure, the experimental absorption curves can be adequately represented by this formula using empirical values of $\bar{\nu}_0$ and $\Delta\bar{\nu}$ to give the best fit at each pressure. The variation of these values is shown in the accompanying graph, where $\bar{\nu}_0$ and $(\Delta\bar{\nu}/p)$ are shown as functions of the pressure (p in atmospheres). At zero pressure $\bar{\nu}_0 = 0{\cdot}78$ cm.$^{-1}$ corresponds to the centre of gravity of the absorption band, and $\Delta\bar{\nu}/p = 0{\cdot}62$ cm.$^{-1}$ per atmosphere corresponds to the average collision diameter of 13·2 A. As the pressure increases, the resonant frequency $\bar{\nu}_0$ shifts steadily downwards, becoming substantially zero at 2 atmospheres and above. At the same time, the value of $(\Delta\bar{\nu}/p)$ decreases, showing that the collision frequency no longer increases linearly with the pressure. (Here the dotted curve at low pressures has no meaning, since the rotational fine structure of the inversion band gives an artificial width not due to collision broadening.)

The initial portion of the $(\Delta\bar{\nu}/p)-p$ curve (up to about 2 atmos.) can be represented by the formula

$$\Delta\bar{\nu} = 0{\cdot}62\, p\,(1 - bp) \text{ cm.}^{-1} \ (p \text{ in atmospheres}), \quad (2)$$



CURVE *a*, $\Delta\nu/p$ AGAINST *p*. CURVE *b*, ν_e AGAINST *p*

where the coefficient b has the value of 0·25 atmos.$^{-1}$. The fall in $(\Delta\bar{\nu}/p)$ may be ascribed to the effect of double collisions. Since the collision diameter is considerably greater than the kinetic theory diameter, an absorbing molecule A will have a colliding molecule B within its sphere of influence for a fraction $\frac{4\pi}{3}\sigma^3 N$ (where N is number of molecules per c.c.) of the total time. If another molecule collides with it during this time, the collision is not effective in contributing to the line-width, since the absorption of radiation was already interrupted. The line-width therefore rises less rapidly than the pressure by the factor $(1 - \frac{4\pi}{3}\sigma^3 N) = (1 - 0{\cdot}23p)$, in close agreement with the experimental formula (2). As the pressure rises still further, the probability of multiple encounters increases, until at about 4 atmospheres the molecule would be spending practically all its life in 'collision'.

The fall in the resonant frequency to zero at about 2 atmospheres represents the destruction of the inversion of the ammonia molecule, either due to the fact that the mean time between collisions $(1/2\pi c\Delta\bar{\nu})$ is then only a fraction of the natural period of the inversion, or to the enormous fluctuating electric fields of the surrounding dipoles. Van Vleck and Weisskopf point out that the formula (1) for the shape of the line should still be valid when $\Delta\bar{\nu} \approx \bar{\nu}_e$. The destruction of the inversion must therefore be ascribed to the electrical interaction, which for two ammonia dipoles with a separation of 27 A. (the mean distance between the molecules at 2 atmos. pressure) corresponds to an energy of 0·5 cm.$^{-1}$. Since each molecule has a number of nearest neighbours, the mean energy will be considerably greater than this, and it seems reasonable that the random electric field can destroy the inversion doublet in the energy levels, and so substitute a non-resonant inversion similar to that observed in heavier molecules. The facts that the line-breadth constant becomes again proportional to the pressure (but with a smaller collision diameter of 7·6 A.) and the total intensity is the same as for the resonant inversion are in agreement with this hypothesis. If, on the other hand, a true Debye absorption, similar to that observed in polar liquids, had set in, the intensity would be greater by a factor of about 2·5, and one might expect the line-breadth constant to be independent of the pressure, like the viscosity of a gas.

To determine whether the destruction of the resonant inversion is indeed due to the electrical interaction and not simply to the high collision frequency, measurements are being undertaken on mixtures of ammonia with non-polar gases at high pressures. In this way it should be possible to increase the value of the line-breadth constant without a corresponding increase in the fluctuating electric field in which the ammonia molecule moves.

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[3] Fröhlich, *Nature*, **157**, 478 (1946).
[4] Bleaney and Penrose, *Proc. Roy. Soc.*, A, **189**, 358 (1947).
[5] Bleaney, Loubser and Penrose, *Proc. Phys. Soc.*, **59**, 185 (1947).

Coefficients of Viscosity and Thermal Conduction in Dense Gases and Liquids

THE coefficients of viscosity and thermal conduction in dense gases and liquids have never been deduced from the molecular point of view owing to the difficulties arising from the statistical treatment of the dense and disordered state. Since a general kinetic theory of liquids has been successfully formulated by Born and Green[1], it has been found possible to deduce these coefficients apart from constant factors. Each of them is seen to consist of two parts, one due to the thermal motion of the molecules and the other to molecular attraction. In every case the radial distribution function plays an important part. For dilute gases, the first part predominates, while for liquids the second part is by far the more important. The different behaviour of liquids and gases in respect to viscosity and thermal conduction can thus be accounted for.

The general expressions for the coefficients of viscosity (μ) and thermal conduction (λ) are, in first approximation,

$$\mu = \frac{(mkT)^{1/2}}{a}\left(1 + \frac{L}{nkT}\right)\left(C_k + C_p\frac{L}{nkT}\right);$$

$$\lambda = \frac{k}{a}\left(\frac{kT}{m}\right)^{1/2}\left(1 + \frac{L}{nkT}\right)\left[A_k + A_p\frac{L}{nkT}\left(1 - \gamma\frac{T\frac{\partial p}{\partial T}}{n\frac{\partial p}{\partial n}}\right)\right];$$

where a is the effective collision diameter which for rigid spheres would be constant and for other force laws varies slowly with temperature, while

$$L = -\frac{2\pi}{3}\int_0^\infty n_2(r)\,\varphi'(r)\,r^3\,dr;$$

$$p = nkT + L.$$

$\varphi(r)$ is the mutual potential energy between a pair of molecules regarded as a function of the distance r between their mean centres only, m the molecular mass, n the number density, k is Boltzmann's con-

stant, T the absolute temperature, $n_2(r)/n$ the radial distribution function and C_h, C_p, A_h, A_p, γ are numerical constants.

The first part of μ and λ can be shown to reduce to the corresponding formulæ in gas theory[2] for the case of rigid spheres, and the relation $\lambda = \mu C_v$, where $C_v = 3k/2m$, can be seen to hold for any model.

It should be possible to fix the constant coefficients if sufficient knowledge of the radial distribution function and its rate of change with density and temperature could be obtained. Theoretical investigations of this problem are now in progress in this Department.

I wish to express my thanks to Prof. Max Born, who suggested this problem to me, and to Dr. H. S. Green for his advice.

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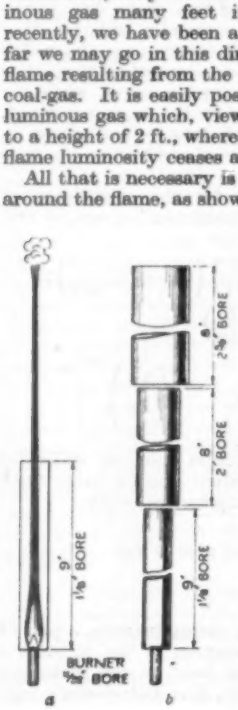
[1] Born, M., and Green, H. S., *Proc. Roy. Soc.*, A, **188**, 10 (1946). Green, H. S., *Proc. Roy. Soc.*, A, **190**, 455 (1947).
[2] Chapman, S., and Cowling, T. G., "The Mathematical Theory of Non-uniform Gases" (Camb. Univ. Press, 1939).

A Bunsen Flame as a Column of Luminous Gas

THE long duration of the luminosity (afterglow) of flame gases after the explosion of a well-mixed inflammable gaseous mixture contained in a large closed vessel, in which cooling takes place slowly[1], suggests that were it possible to secure steady streamlined flow of the flame gases rising from a very large open flame, thus eliminating cooling due to turbulence, they would appear as a column of luminous gas many feet in height. Experimenting recently, we have been a little surprised to find how far we may go in this direction with a small Bunsen flame resulting from the combustion of fully aerated coal-gas. It is easily possible to obtain a column of luminous gas which, viewed in a dark room, extends to a height of 2 ft., whereas with the ordinary Bunsen flame luminosity ceases at a height of only 7 or 8 in.

All that is necessary is to hold an open-ended tube around the flame, as shown in Fig. *a*. It is important that a tube of the right diameter and length in relation to the burner diameter should be selected. The dimensions of the tube used in our experiments are given in the figure.



An even greater height of luminous gas column—approaching 3 ft.—may be attained by the use of a series of open-ended tubes of increasing diameter placed one above the other, as shown in Fig. *b*.

It would appear that the flame gases become embedded in a column of expanding air rising through the tube, and the turbulent mixing with cold air, which always takes place near the tip of an ordinary flame (see *Schlieren* photographs[1]), is thus inhibited. The provision of additional tubes above the first appears to assist in maintaining the streamline flow.

The first six inches or so of the flame gases are yellow in colour. They then turn to red and quickly afterwards to blue, which persists through the whole length of the column. The yellow coloration indicates continued combustion above the inner cone due to stratification of the gas mixture in the flame resulting from imperfect mixing of the coal-gas and air during their passage up the burner tube. When a perfectly mixed coal-gas and air mixture (with excess air) contained in a tank is supplied to the burner (with the air port closed) there is no yellow coloration—the flame gases attain their reddish colour immediately above the inner cone and this turns quickly to the characteristic blue afterglow which persists as before.

We have obtained a similarly extended afterglow when burning pure carbon monoxide in the Bunsen burner.

We would again like to suggest that it is difficult to account for the long duration of the afterglow unless the presence in the flame gases of metastable molecules formed during combustion is assumed[1]. The excited molecules responsible for the light emission may result from the collisions of these molecules.

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[1] *Nature*, **159**, 407 (1947).
[2] Gawthrop, *Rev. Sci. Instr.*, **2**, 522 (1931).

Equations of Piezo-electricity

PROF. W. G. CADY'S exposition of the basic equations of piezo-electricity in his recent book "Piezoelectricity" contains errors which should be brought to the attention of students and workers in this field.

On p. 44, the first thermodynamic potential is introduced in equation (1), but is incorrectly expressed as a quadratic form in terms of elastic strains and electric field intensities within the piezo-electric material (we are considering only isothermal effects here). This potential is also called Green's strain-energy function, and is identical with the Lagrange function for a statical conservative system. It is well known that, for a linear conservative system, this function can be written either as a quadratic form in the generalized co-ordinates, in which case it is sometimes called the 'first thermodynamic potential', or as a quadratic form in the generalized forces, when it is called the 'second thermodynamic potential'. For an electromechanical system, suitable generalized co-ordinates are elastic strain and electric displacement, and the corresponding generalized forces are elastic stress and electric field intensity. By using elastic strain and electric field intensity in equation (1), however, Prof. Cady mixes generalized co-ordinates and forces in the Lagrange function, which results in erroneous piezo-electric equations. The second thermodynamic potential is introduced in equation (2) on p. 44, and is correctly written as a quadratic form in elastic stress and electric field intensity. Equations based on (1) will be physically inconsistent with equations based on (2).

Theoretical conclusions drawn from the incorrect equation (1) by the usual Lagrange formalism

permeate the whole of Chapter 8 on the principles of piezo-electricity. The correct equation (2) is also used as a basis for many of the equations in this same chapter, and the reader is therefore obliged to examine closely the origin of the formulæ he uses. The formulæ affected are the basically important linear equations which give the elastic stresses and electric field intensities as functions of the elastic strains and electric displacements.

The basic formulæ are used in subsequent chapters on the piezo-electric properties of certain crystals, on alternative formulations of piezo-electricity theory, and on secondary piezo-electric effects. On page 252 of the chapter on alternative formulations of theory, incidentally, the author introduces equations (243) and (243a), which are similar to (1) and (2), and in which again generalized forces and co-ordinates are incorrectly mixed in the Lagrange function.

Prof. Cady's book fills the need for a comprehensive summary of the recent experimental researches; the mathematical portions, however, require revision.

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The Melanin Problem: a Synthesis of 5 : 6-Dihydroxyindole

WE have recently submitted to the Chemical Society a paper describing, *inter alia*, a new synthesis of 5-hydroxyindole by reduction with iron powder and acetic acid of 2 : β-dinitro-5-acetoxystyrene and deacetylation of the resulting 5-acetoxyindole. As a part of a comprehensive investigation of the chemistry of the natural melanins, we have now successfully extended the method to the synthesis of 5 : 6-diacetoxyindole (compact hemispherical clusters, m.p. 135–136°; found: C, 61·5; H, 4·9; N, 6·3: $C_{12}H_{11}O_4N$ requires C, 61·8; H, 4·7; N, 6·0 per cent), and of 5 : 6-dihydroxyindole (colourless needles, m.p. 140°; found: C, 64·7; H, 4·85; N, 9·4: $C_8H_7O_2N$ requires C, 64·4; H, 4·7; N, 9·4 per cent). The latter compound was postulated by Raper[1] as an unstable intermediate in the enzyme-catalysed oxidation of tyrosine to melanin, and has been known hitherto only in solution or in the form of its derivatives.

Treatment of the alkaline deacetylation mixture with dimethyl sulphate, without isolation of the hydroxyindole, yielded the dimethyl-ether (m.p. 155°, in agreement with Raper's 5 : 6-dimethoxyindole, m.p. 154–155°; found: C, 67·6; H, 6·0; calculated for $C_{10}H_{11}O_2N$ C, 67·8; H, 6·2 per cent).

Crystalline 5 : 6-dihydroxyindole is surprisingly stable, but in slightly alkaline solution very rapid oxidation occurs with formation of melanin-like products. A study of the oxidation of this dihydroxyindole, its alkyl substitution products and related compounds, which have been synthesized, is in active progress.

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[1] *Biochem. J.*, **21**, 89 (1927).

The Carotenoids of the Locust Integument

As part of a research programme into the biochemistry of locust pigmentation, the carotenoids of the integument of *Locusta migratoria migratoroides* R. and F. and *Schistocerca gregaria*, Forsk. have been investigated. There is apparently no reference in the literature to the pigment of *Locusta*, and only two rather tenuous and contradictory reports have appeared concerning that of *Schistocerca*[1,2]. Lederer[1] quotes unpublished work with Volkonsky indicating that the rose pigment of young *Schistocerca* is not a carotenoid but that the yellow pigment of the mature insect is; Chauvin[3] reported an unidentified rose-coloured carotenoid in immature, and a mixture of α- and β-carotene in mature, insects.

The insects used in the present investigation were bred in captivity and fed solely on grass. The pigment in the hypodermis of both *Locusta* and *Schistocerca* is the same and undoubtedly astaxanthin[3]. Its identity has been established by comparing its properties with an authentic specimen of astaxanthin isolated from lobster carapaces. Both compounds gave identical absorption spectra in three solvents, namely, petroleum-ether, b.p. 40–60°, pyridine and carbon disulphide; a mixture of the two pigments could not be separated chromatographically. Further, the locust astaxanthin reacted with potassium butoxide *in vacuo* to form a purplish-blue enol salt, and was converted into astacene by alkali in the presence of oxygen. The astacene formed was indistinguishable from lobster astacene.

Partition experiments indicate that astaxanthin occurs in the free form and is not esterified. It occurs in both the solitary and gregarious phases, and at all stages of development up to sexual maturity; up to this stage it is the predominant carotenoid present. It must be formed by the insect, for it does not occur in the diet.

At sexual maturity β-carotene, always present in the fatty tissues of the insects, begins to accumulate in the hypodermis and the astaxanthin to disappear. This observation confirms and explains the work of Chauvin and of Lederer on mature insects. It is, however, difficult to accept unreservedly Lederer's contention that the yellow pigmentation of mature *Schistocerca* is entirely due to carotenoids; so-called acridioxanthin[4] undoubtedly plays some part. This disappearance of astaxanthin, with replacement by β-carotene, at sexual maturity has no obvious explanation at present; but it is another addition to the growing mass of observations which suggests a relationship between carotenoid metabolism and sexual function. It is interesting to note that astaxanthin is also present in the eyes of locusts in both mature and immature insects.

The pigmentation of the gonads and fatty tissues of both species is due almost completely to β-carotene; there may be a little α-carotene present but no traces of xanthophylls could be detected; the amount of β-carotene which accumulates, especially in older insects, is considerable. Previous workers[1] have claimed that this pigmentation is due to a mixture of carotenes and xanthophylls but, more recently, Grayson[5], and Grayson and Tauber[6] have reported findings on another acridid (*Melanoplus bivattus* Say.) which are in substantial agreement with ours, although they report the presence of traces of xanthophylls.

The demonstration of astaxanthin in locusts is particularly interesting because, apart from its

detection in the retina and eye colourings of birds[7,8], this is the first time it has been reported in land animals. This is perhaps less surprising when one considers that locusts are quite closely related to the Crustacea, the typical carotenoid of which is astaxanthin.

We are grateful to the Anti-Locust Research Centre for supplying material and for a grant towards expenses.

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Dec. 22.

[1] "Les Carotenoides des Animaux", 28 (Hermann, Paris, 1935).
[2] *Ann. Soc. Ent. France*, **110**, 133 (1941).
[3] Kuhn, R., and Sorensen, N. A., *Z. Angew. Chem.*, **51**, 465 (1938).
[4] Chauvin, R., *C.R. Soc. Biol.*, **211**, 339 (1940).
[5] *Iowa State Coll. J. Sci.*, **17**, 69 (1942).
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Isolation in Chick Embryos of a Filtrable Agent possibly related etiologically to Lumpy Skin Disease of Cattle

THE widespread occurrence of lumpy skin disease[1] in dairy herds of the Cape Peninsula offered suitable material for investigations on the etiology of this disease.

Skin nodules or lymph gland excised under local anæsthesia from cases in the early stages of the disease as well as tissues obtained at post mortem were made available to us. Emulsions of these tissues, treated with antibiotics or freed of bacteria by filtration through 'Gradocol' membranes[2], were used for the inoculation of laboratory animals and chick embryos.

Inoculation of laboratory animals by the usual routes has so far proved unsuccessful.

One series of experiments using chick embryos has, however, resulted in the isolation of a virus. The starting material was obtained from a calf which died at a stage of the disease when active skin and lymph gland lesions were still present. An emulsion was made in broth of a lymph gland and a skin nodule. After light centrifugation and removal of the supernatant, penicillin (100 μ per ml.) and streptomycin (50 γ per ml.) were added, and the emulsion then filtered through a 'Gradocol' membrane with an average pore diameter of 600 mμ. The filtrate was used for the inoculation of six nine-day-old chick embryos by the combined amniotic and chorio-allantoic routes.

The eggs were returned to an incubator and maintained at 35–36° C. Four of the embryos were dead on or before the sixth day after inoculation. One of the survivors, opened on the sixth day, showed a marked gelatinous œdema of the chorio-allantois and numerous hæmorrhages into the shafts of the feather follicles.

Serial passages of embryo and chorio-allantois have been maintained since then for more than a year. Nine-day embryos are usually employed, and lesions developed by them are constant. On the fourth day after inoculation, the embryos present a characteristic shrivelled appearance—tightly rolled up in a dry, thickened, amniotic membrane. Feather development is usually absent, or only irregularly swollen cystic or hæmorrhagic feather follicles are present. The chorio-allantoic membrane almost invariably shows gross gelatinous œdema. That the agent responsible for these lesions is a virus is suggested by: (*a*) the presence of numerous inclusion bodies in histological sections of affected embryos; and (*b*) the development of lesions following the inoculation of filtrates through 'Gradocol' membranes with A.P.D. of 52 mμ or more; filtrates through 21 mμ membranes have regularly failed to elicit the characteristic lesions.

Successful neutralization experiments have been carried out in eggs, with immune sera from adult fowls that had received repeated injections of the virus cultivated in chick embryos, as well as sera from convalescent bovines. Results of neutralization tests have, however, not always been conclusive, because positive results have been obtained with the serum of occasional apparently normal bovines. The possibility that these apparently normal animals had suffered subclinical infections could not, however, be excluded. Also, one serum from a bovine convalescent after a typical attack of lumpy skin disease contained no demonstrable neutralizing antibody.

A small number of normal bovines obtained from areas where the disease was not endemic have been tested for their susceptibility to the virus cultivated in eggs. None of these has developed lumpy skin disease. The experimental transmission of the disease in its natural host has, however, proved uncertain even when presumably infective inocula obtained from other bovines have been used. Furthermore, it would not be surprising in the light of experience with other animal viruses if serial transfer in eggs has resulted in a loss of virulence for the original host.

Although the identity of the virus has not yet been definitely established, it is felt that the successful neutralization by the majority of lumpy skin convalescent sera tested indicates the possible etiological relationship of this virus to lumpy skin disease.

Full details of the experiments will be published elsewhere.

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[1] de Boom, H. P. A., *S. African Sci.*, **1**, 44 (1947). Thomas, A. D., and Maré, C. v. R., *J. S.A. Vet. Med. Assoc.*, **16**, 36 (1945). von Backström, U., *J. S.A. Vet. Med. Assoc.*, **16**, 29 (1945).
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Effect of Calcium Ions on the Charge of Myosin

DURING a preliminary investigation of the electrophoretic behaviour of the crystalline myosin prepared according to Szent-Györgyi[1] we found, in a Tiselius electrophoresis cell, that myosin was negatively charged when dissolved in potassium chloride at *p*H 7·1.

Based upon these data, Szent-Györgyi suggested that myosin dissolved in an excess of calcium chloride at the same *p*H ought to be positively charged. Our present experiments confirm this suggestion.

Some data of our preliminary work are summarized in the accompanying table.

ONCE-CRYSTALLIZED MYOSIN DISSOLVED IN THE GIVEN BUFFER. CONCENTRATION OF MYOSIN 0·3 PER CENT

	*p*H	Mobility
0·28 *M* KCl	7·1	−2·5
0·12 *M* K-veronale-acetate-HCl buffer of Michaelis	5·6	+1·6
0·22 *M* $CaCl_2$	7·5	+1·27
0·04 *M* K-veronale-acetate-HCl buffer of Michaelis	8·7	+1·28

The isoelectric point of myosin is about *p*H 5·4. The figures show that the isoelectric point of our calcium myosinate is at a *p*H greater than 8·7. Myosin is precipitated under our experimental conditions in the presence of potassium chloride in the *p*H-range 5–6, but in the presence of calcium chloride the myosin is completely soluble in this range.

The difference between the isoelectric points of potassium myosinate and calcium myosinate is undoubtedly unusually large, and it seems to us that this example of potassium – calcium antagonism is of physiological importance.

The investigations are being continued and a detailed description will appear elsewhere. We wish to express our thanks to Prof. Arne Tiselius for his interest in the work. The investigation is financially supported by Svenska Naturvetenskapliga Forskningsrådet.

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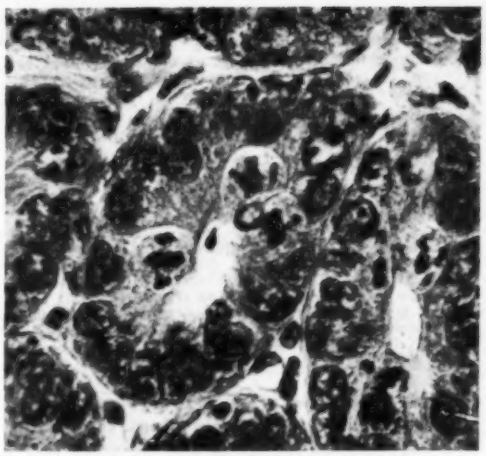
[1] Szent-Györgyi, A., *Acta Physiol. Scand.*, 9, suppl. 25 (1944).



GERMINATIVE REGION OF THE SMALL INTESTINE OF MOUSE

Carnoy fixation, iron-hæmatoxylin staining. In one crypt, three mitoses are arrested. The greatest part of their chromosomes lies in the equatorial region, while small groups of chromosomes have already reached the poles (two hours after 0·135 mgm./gm. hydroquinone)

Early Effects of Hydroquinone on Mitosis

ONE of us recently directed attention[1] to the 'radiomimetic' action of hydroquinone. In the intestine of the mouse, extensive nuclear destruction, occurring before the onset of prophase in the cells of the germinative region, was observed four hours after an injection of 0·125 mgm./gm. The interest taken in this type of mitotic poisoning has been increased by the description by Mitchell and Simon-Reuss[2] of the synergic effects of X-rays and a vitamin K substitute (diphosphoric ester of methylnaphthoquinone) on mitosis in normal and cancerous tissues. Naphthoquinone is known to be a mitotic poison[3]. A further investigation of the cytological disturbances following the injection of various quinone and phenolic compounds has led to the observation in the small intestine of the mouse of a new type of abnormal mitosis.

During the first two hours after hydroquinone injection, preceding the 'radiomimetic' (pycnotic) effect, there is a progressive accumulation of arrested metaphases. After intraperitoneal or subcutaneous doses of 0·15 or 0·175 mgm./gm., the percentage of metaphases may rise as high as 92 per cent, while normal ana- and telo-phases nearly completely disappear. Some of the metaphases show an irregular distribution of the chromosomes, which are short and thick and may clump together in the middle of the cell. Most of the divisions, however, assume a very peculiar appearance (see accompanying reproduction). On each side of the metaphase plate, little groups of chromosomes migrate towards the poles. These chromosomes are usually the smallest ones, and their movements are caused by the presence of an apparently well-developed spindle, easily demonstrated after Carnoy fixation.

Various hypotheses may be used to explain the origin of these abnormal mitoses, which bear a curious resemblance to those normally found in the egg of *Miastor Americanus*[4].

(1) The central mass may be formed of fragments broken off from the migrated chromosomes. But at 30 min. and one hour after the injection, when the chromosomes are still clearly defined, only a few of them have migrated to the poles, and there is no evidence that these have yet been broken.

(2) Signs of chromosome 'stickiness' are particularly apparent from one hour onwards after the injection. The central mass of chromosomes clumps more and more together, and bridges may be observed between it and the polar chromosomes. But this is only a secondary change, the abnormal migration taking place when the limits of the equatorial chromosomes are still visible.

(3) Through a defect of the spindle, chromosomes could be 'lost' before the anaphasic migration: v. Moellendorff, in tissue cultures treated with various mitotic poisons, has described such 'detached' chromosomes[5]. However, after hydroquinone poisoning, the spindle appears to be normal, its fibres are quite conspicuous, and it is difficult to understand how so many chromosomes at a time could break loose from the spindle.

(4) An intrinsic cause of the abnormal chromosome migration appears to be the most probable. It is suggested that an impeded division of the centromeres of the longest chromosomes gives the best explanation of the peculiar mitotic figures.

These results help to explain why benzoquinone and naphthoquinone have been considered as mitotic poisons of the colchicine type by several authors[3], while hydroquinone and other diphenols appeared to have in mice a typical radiomimetic effect[1]: the early modifications of mitosis described above have some resemblance to the colchicine effect (accumulation of metaphases), whereas later, when no more cells enter division, pycnosis and cellular disintegration sets in, as after irradiation. It is of interest to note that mitotic abnormalities similar to those illustrated above have been described as one of the primary or 'physiological' effects of irradiation[6]. Research now in progress may eventually help to simplify the classification of the various types of poisoned mitoses and explain the fundamental changes in cell metabolism underlying them.

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Antagonism Between Molybdenum and Certain Heavy Metals in Plant Nutrition

IT has been recognized in the literature that an excess of either manganese, zinc, copper, cobalt or nickel will induce iron-deficiency chlorosis in plants. Other toxic effects such as stunting and lower leaf necrosis may also occur. These effects have been confirmed in water-culture experiments with flax, conducted at the Plant Research Laboratory, Department of Agriculture, Burnley, Victoria.

In these experiments, it has been further shown that it is possible to reduce the severity of iron-deficiency symptoms, caused by an excess of any one of the above elements, by increasing the supply of molybdenum to the solution. Various concentrations of added molybdenum up to 20 parts per million have been used.

In the case of excess manganese (5–100 p.p.m.), which has been the heavy metal treatment most intensively studied, the added molybdenum reduced the severity of lower leaf necrosis, which is a characteristic manganese-toxicity symptom. A preliminary paper on this subject will be published in a forthcoming issue of the *Journal of the Australian Institute of Agricultural Science*. This describes experiments with flax. Manganese/molybdenum antagonism has since been demonstrated in water-culture experiments with peas, cabbages and tomatoes.

In Victoria, on highly acid soils, a previously undescribed disease of flax occurs which has been called 'lower leaf scorch'. Previous to the water-culture work outlined above, it was found that lower leaf scorch could be prevented by liming, and aggravated by sulphur, steam sterilization, or manganese sulphate. Affected plants were found to contain a higher manganese concentration than normal. In the past two seasons the disease has been prevented, in both pot and field experiments, by applying small amounts of ammonium molybdate (1–2 lb. per acre). In further pot experiments with highly acid soils (*p*H 4·8), heavy dressings of manganese sulphate (up to 10 cwt. per acre) caused severe lower leaf scorch. However, where ammonium molybdate (2 lb. per acre) was added with the heavy dressings of manganese sulphate, the severity of manganese-induced lower leaf scorch was much reduced. Applications of some samples of superphosphate have been effective in preventing lower-leaf scorch of flax. Such samples have been found to contain significant amounts of molybdenum impurity.

In a preliminary experiment, I have found that flax grown in water-cultures without molybdenum, but with a normal supply of manganese and iron, has shown a slight general chlorosis, and a necrosis of the lower leaves commencing at the edges. These symptoms appeared to be similar, if not identical, with those of lower leaf scorch or manganese toxicity.

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Synonymy of the Nudibranch Genera *Pellibranchus* and *Okadaia*

SINCE the publication of a paper[1] describing *Pellibranchus cinnabareus* as a new genus and species of non-pelagic nudibranch mollusc, Dr. Nils H. J. Odhner, of the Riksmuseet, Stockholm, has pointed out to me that *Pellibranchus* is a synonym of *Okadaia* Baba[2]. *Okadaia* contains small nudibranchs less than 5 mm. in length, limaciform, head and foot not carinate; rhinophores simple, contractile, without sheaths; mouth slit-like; gills absent; anus and nephroproct opening slightly to the right of the mid-dorsal line, about a third of the way back from the head; genital orifices obliquely in front of the anus on the right side of the body; jaw plates absent; radula formula, 3, 0, 3; liver divided into three or four lobes; true heart not enclosed in a pericardium; gonads consisting of two or three testes and five or six ovaries; development is direct. These are the characters of the nudibranch described in my paper, and *Pellibranchus* is clearly a synonym of *Okadaia* which now contains *Okadaia elegans* Baba, 1930, the type from Japan, and *Okadaia* (= *Pellibranchus*) *cinnabareus* (Ralph, 1944) from New Zealand.

Both *O. elegans* and *O. cinnabareus* frequent the intertidal zone. Towards the beginning of October, *O. elegans* begins to lay eggs underneath stones. Adult animals and eggs of *O. cinnabareus* can be found under the surface of stones at all seasons of the year. *O. elegans* is most abundant from January to April. Specimens of *O. elegans* are known to occur along the Pacific Ocean side of Japan from Tomoika (Amakusa) to as far north as Akkeshi (Hokkaidô). At present *O. cinnabareus* is known only from tidal runnels along the shore at Island Bay, Wellington.

O. cinnabareus is distinguished from *O. elegans* principally on the structure of the teeth comprising the radula. The first lateral of *O. elegans* has one denticle outside the cusp and two inside, whereas in *O. cinnabareus* the first lateral has only one denticle, which is situated inside the cusp. The third lateral of *O. elegans* takes the form of a squarish plate; but in *O. cinnabareus* it is more conical. Baba[3] gives the colour of *O. elegans* as light orange-yellow. *O. cinnabareus* is bright red. Baba counted 27–54 heart-beats per minute through the transparent integument of *O. elegans*. It is not possible to count the heart-beats in *O. cinnabareus* as the integument is heavily pigmented and non-transparent. Full accounts of the two species have appeared in the *Japanese Journal of Zoology*[2] and the *Transactions of the Royal Society of New Zealand*[1].

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MASS-DEFECTS OF THE HEAVY ISOTOPES

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IN preparing the tables for Prof. L. Rosenfeld's book[1] I noticed that an error was made in the mass-defects of the heavy isotopes as given in the "Isotopenbericht 1942" of Flügge and Mattauch[2]. The difference of the mass-defects $\Delta\varepsilon$ in every β-decay was taken equal to the maximum energies of the β-particles, eventually increased by the γ-energies. No correction was made for the fact that a neutron changes into a lighter proton, so that the mass-defect difference is

$$\Delta\varepsilon = 0{\cdot}754 \text{ MeV.} - E_\beta.$$

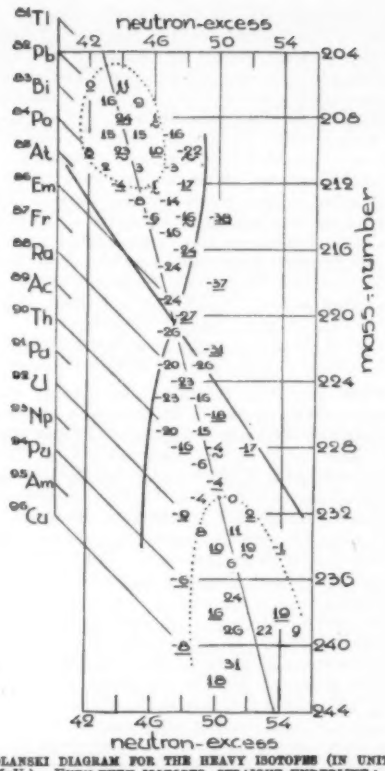
Because this error accumulates in each successive β-decay, the error in the mass-defects difference between the extreme members of each radioactive family is about 4 MeV.

In the accompanying table we give more correct data for the differences in mass-defects relative to Pb^{206}. For the α- and β-energies used, see refs. 3 and 4. The mass-defects of the thorium family are adjusted to those of the uranium family on the assumption that the mass-defects of the lead, polonium and thorium isotopes, all of which belong to the even-even type, should each lie on a parabola. This adjustment can be made with a mean error of 0·5 MeV.

The position of the isotopes of the actinium and neptunium families was more difficult to determine. We used for this purpose a special diagram[5]. In this diagram the difference of the mass-defects from a well-chosen linear function of the mass-number A is written instead of the isotopes in an A—n diagram (n = neutron-excess). This diagram permits the study of the energy surfaces in greater detail than has hitherto been possible. With its aid we discovered that to a close approximation the three energy surfaces (of the even-even, odd-odd and even-odd nuclei) are parallel even in detail: it was possible to bring the diagrams of the three kinds of isotopes on to one drawing by only varying the constant in the linear functions. This has been done[1] for the lighter elements (A less than 65) using the linear functions

(even-even) $9{\cdot}175\ A - 25{\cdot}0$ MeV.
(odd-odd) $9{\cdot}175\ A - 28{\cdot}5$ MeV.
(even-odd) $9{\cdot}175\ A - 27{\cdot}0$ MeV.

The difference between the (ee)- and (oo)-surface is thus 3·5 MeV., and the (eo)-surface is almost midway between them. Now, from the results for the uranium family it is possible to deduce the difference between the (ee)- and (oo)-surface in the region of the heavy isotopes by assuming that the two (ee)- and the two (oo)-isotopes in it with mass-number 210 should be situated on two parallel parabolas. The difference is 2·03 MeV. If we may suppose that the (eo)-surface is situated halfway between the (ee)- and the (oo)-surfaces, we can give also the mass-defects of the (eo)-isotopes, that is to say, the actinium and neptunium families. It is thus necessary to see if the (eo)-surface is parallel to the other energy surfaces in this case also.



PODOLANSKI DIAGRAM FOR THE HEAVY ISOTOPES (IN UNITS OF 0·1 MeV.). EVEN-EVEN ISOTOPES, STRAIGHT UNDERLINE; ODD-ODD ISOTOPES, WAVY UNDERLINE; EVEN-ODD ISOTOPES, NO UNDERLINE. CONTOUR LINES FOR 0 AND −2·5 MeV. THE STRAIGHT LINE IN THE MIDDLE IS THE LINE OF MAXIMUM MASS-DEFECTS FOR ISOBARS

MASS-DEFECTS OF THE HEAVY ISOTOPES RELATIVE TO Pb^{206}

U family		(MeV.)	Th family		(MeV.)	Ac family		(MeV.)	Np family	(MeV.)
Cm^{242}		199·82	Cm^{240}		186·26	U^{229}		181·29	Am^{241}	194·74
Pu^{238}		177·62	Pu^{236}		164·43	Np^{229}		182·60	Np^{237}	172·11
U^{238}	UI	177·90	U^{232}		142·09	Pu^{229}		183·03	Pa^{233}	148·77
Th^{234}	UX_1	153·92	Th^{228}	Th	143·22	U^{233}	AcU	160·09	U^{233}	148·47
Pa^{234m}	UX_2	153·47	Ra^{224}	$MsTh_1$	119·31	Th^{229}	UY	136·49	Th^{229}	125·19
Pa^{234}	UZ	153·86	Ac^{228}	$MsTh_2$	118·61	Pa^{231}	Pa	136·09	Ra^{225}	101·94
U^{234}	UII	155·04	Th^{228}	RdTh	119·41	Ac^{227}	Ac	113·04	Ac^{225}	101·23
Th^{230}	Io	131·64	Ra^{224}	ThX	96·74	Th^{227}	RdAc	112·51	Fr^{221}	78·94
Ra^{226}	Ra	108·21	Em^{220}	Tn	74·34	Fr^{223}		89·95	At^{217}	57·17
Em^{222}	Rn	84·90	Po^{216}	ThA	52·55	Ra^{223}	AcX	90·48	Bi^{213}	36·13
Po^{218}	RaA	62·30	Pb^{212}	ThB	31·26	Em^{219}	An	68·11	Po^{213}	36·73
Pb^{214}	RaB	40·22	Bi^{212}	ThC	31·10	Po^{215}	AcA	46·87	Tl^{209}	13·91
Bi^{214}	RaC	40·39	Po^{212}	ThC′	32·60	Pb^{211}	AcB	26·19	Pb^{209}	17·03
Po^{214}	RaC′	43·39	Tl^{208}	ThC″	9·10	Bi^{211}	AcC	26·84	Bi^{209}	16·95
Tl^{210}	RaC″	17·81	Pb^{208}	ThD	13·36	Po^{211}	AcC′	26·72		
Pb^{210}	RaD	23·03				Tl^{207}	AcC″	5·39		
Bi^{210}	RaE	22·32				Pb^{207}	AcD	6·11		
Po^{210}	RaF	22·79								
Pb^{206}	RaG	0								
Tl^{206}		−0·95								

For this purpose we have again used a similar diagram. The figures on this diagram of both new families were easy to find by assuming that the lead, polonium and thorium isotopes should be situated on the same parabolas we have already used for the uranium and thorium families. This adjustment was made with a mean error of 0·7 MeV. for the actinium family and 0·5 MeV. for the new neptunium family. This last result is interesting as showing that the experimental values given for the decay energies of these new isotopes are rather accurate. The reliability of the mass-defects we have found from them is still more strikingly confirmed by the fact that the resulting diagram exhibits a much better consistency than was expected. The linear functions used were:

$$\text{(ee)}\ 5{\cdot}5(A-206) + \varepsilon(\mathrm{Pb}^{206})$$
$$\text{(oo)}\ 5{\cdot}5(A-206) + \varepsilon(\mathrm{Pb}^{206}) - 2{\cdot}03$$
$$\text{(eo)}\ 5{\cdot}5(A-206) + \varepsilon(\mathrm{Pb}^{206}) - 1{\cdot}0.$$

We feel justified, therefore, in placing the (oe)-isotopes midway between the (ee)- and (oo)-surfaces. By this means we have made the accompanying table of the differences of the mass-defects of the heavy isotopes from that of Pb^{206}. They are believed to have an error of about 0·8 MeV. Differences for members of the same family are much more accurate, except in the actinium family, where the decay energy of uranium Y (Th^{231}) is unknown. We have taken for its mass-defect that situated on the thorium parabola used above.

Notes added in proof. (*a*) The value for U^{235} in the diagram should be 16 instead of 6; (*b*) with the decay scheme of N. Feather (*Nature*, **160**, 749; 1947) the mass-defect of U^{239} in the table becomes 182·15 and its value in the diagram 17.

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CONSTITUTION OF CERTAIN BINUCLEAR METALLIC CARBONYLS AND NITROSYLS

By Dr. R. V. G. EWENS

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JENSEN AND ASMUSSEN[1] have recently made some interesting suggestions concerning the nature of the bridge links in polynuclear complex inorganic compounds, and one of the examples they discuss is iron enneacarbonyl, $Fe_2(CO)_9$. Now the X-ray evidence[2] shows that the structure is essentially that shown in Fig. 1,

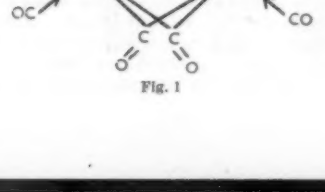

Fig. 1

in which a direct Fe–Fe link accounts for the observed interatomic distance and for the diamagnetism of the molecule. Without such a bond, each iron would be trivalent, with an effective atomic number of 35, as in the paramagnetic $K_3[Fe(CN)_6]$ and in the binuclear 1 : 10-phenanthroline iron (III) complex (Fig. 2),

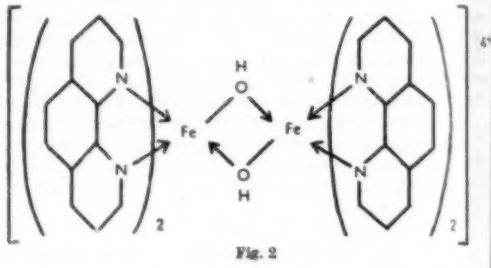

Fig. 2

where an unpaired electron spin is associated with each iron (III) atom[3]: but with the metal–metal bond the effective atomic number becomes 36 as in the diamagnetic compounds $K_4[Fe(CN)_6]$ and $Fe(CO)_5$.

Jensen and Asmussen make the alternative suggestion that the diamagnetism of the enneacarbonyl could be accounted for by resonance between bridge structures which may readily be simplified (Figs. 3 and 4) *without* the assumption of a metal–metal bond.

Fig. 3

Fig. 4

While such a formulation gives even effective atomic numbers to both iron atoms, 34 to the 'donor' and 36 to the 'acceptor' (numbers which are not affected by the resonance $O \rightleftarrows C \rightarrow M \sim O = C = M$ in the terminal carbonyl groups), and might thus explain the observed diamagnetism, it does not, in fact, dispense with an Fe–Fe bond. For if these structures are written in the alternative way with $\overset{+}{B} - \overset{-}{A}$ instead of $B \rightarrow A$, they become Figs. 5 and 6. It

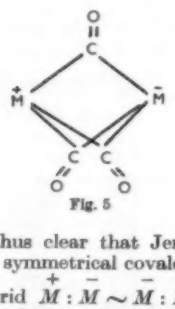

Fig. 5

Fig. 6

is thus clear that Jensen's scheme simply replaces the symmetrical covalent M—M link by a resonance hybrid $\overset{+}{M} : \overset{-}{M} \sim \overset{-}{M} : \overset{+}{M}$ derived from the extreme ionic forms. Such a mesomeric state is tantamount to a link with sufficient covalent character to justify the use of the single symbol Fe–Fe, any contribution from such ionic states being implied in the customary manner.

Moreover, Jensen and Asmussen's supposition demands a resonance between two valency states (formally II and IV). Now numerous complexes of this type are known and, as these authors point out elsewhere in the same paper, the resonance is associated with intense colour. But the colour of iron enneacarbonyl is only orange-yellow, and the cobalt carbonyl $Co_2(CO)_8$, the formulation of which entails the same difficulty, is but a pale yellow, so that this evidence certainly offers no support for Jensen and Asmussen's view.

It would, however, be very curious if this rare type of metal–metal linkage were confined to iron enneacarbonyl; but it appears certain that other examples exist. Thus the dimeric and diamagnetic cobalt tetracarbonyl $Co_2(CO)_8$ can be formulated as in Fig. 7,

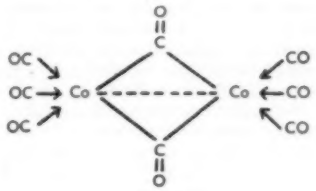

Fig. 7

in which the cobalt, initially with one electron more than iron, requires one carbonyl bridge less to become isoelectronic (effective atomic number 36) with the metal atom in the diamagnetic $K_3[Co(CN)_6]$ and the diamagnetic iron compounds above.

'Roussin's red salt' and its analogues form an even more interesting group of compounds, the structures of which may be explained in a similar manner. These compounds are all of the type $Fe(NO)_2X$, where X may be $—S^-K^+$ (the original red salt), $—Cl$[4], $—I$[5], $—S.C_2H_5$, $—S.C_6H_5$, or $—S.SO_3^-K^+$ (the thiosulphate). Of these the chloride and the ethyl and phenyl esters have been shown to be dimeric, while Roussin's red salt itself[6] and the thiosulphate[7] have been shown to be diamagnetic, so that we may fairly assume the degree of polymerization and the magnetic behaviour to be the same for all these substances. They may then be assigned the general structure shown in Fig. 8, in which each nitrosyl

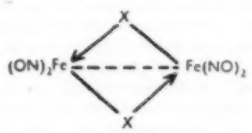

Fig. 8

group contributes three electrons to the metal atom (as in $\bar{M} - \overset{+}{N} \equiv \overset{+}{O} \sim \overset{+}{M} = \bar{N} = O$[8]). In addition, each iron atom acquires three electrons from the bridging groups and one from the Fe–Fe link, giving $26 + 2 \times 3 + 3 + 1 = 36$ as the effective atomic number.

An earlier view, that these compounds are really hyponitrites, has been criticized by Manchot[9], and is rendered the more unlikely by the observations that iron dinitrosyl dicarbonyl $Fe(NO)_2(CO)_2$, in which the NO groups are distinct[3], reacts smoothly with iodine[5] and with benzenethiol[10] to give the corresponding Roussin-type compounds. This being so, the above bridged structure is the only plausible alternative, and the Fe–Fe link is then necessary to explain the diamagnetism.

Even the more complicated Roussin's black salt $K[Fe_4(NO)_7S_3]$ can be explained on similar lines. A fuller account of this and other matters related to the above discussion will be published elsewhere in due course.

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CHROMOSOMAL EVOLUTION IN THE EUROPEAN MOLE-CRICKET

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IT is well known that species belonging to the same genus frequently differ in their chromosomal numbers. Special interest is attached to this diversity, since it may furnish a clue to the mode of evolution of the species. Although reduction in number of chromosomes appears to occur fairly frequently, practically nothing is known about their increase in numbers except by polyploidy, which occurs very rarely in animals. The European mole-cricket (*Gryllotalpa gryllotalpa* L.) is a most interesting example of a progressive increase in chromosome number within the limits of the same species. It would appear that speciation based on diversification of chromosome numbers is here at work.

The species *G. gryllotalpa* may be divided into four geographical races which differ in their chromosomal numbers. The northern race found in Belgium, Germany, France and northern Italy has 12 chromosomes (10 autosomes and XY)[1,2]. In Roumania there is a second race with 14 chromosomes (12 autosomes and XY)[3]. A third race in central Italy is characterized by 15 chromosomes in the male (14 autosomes and X)[4], while a type with 17 chromosomes was observed in southern Italy[5]; the same type has recently been found by Barigozzi[6].

Barigozzi[7] and de Winiwarter[8] suggested that fragmentation of two pairs of anisobrachial metacentric chromosomes of the northern race may have given rise to the two additional small pairs characteristic of the central Italian type. This hypothesis is certainly much too simple, as it is well known that acentric fragments are non-viable. White[8], on the other hand, postulated that evolution occurred by reduction of the number of chromosomes, since two species of *Gryllotalpa*, namely, *G. borealis* and *G. africana* and a related genus *Scapteriscus*, have 23 chromosomes (22 autosomes and X).

In a cytological study of the Palestinian mole-cricket, which belongs to *G. gryllotalpa*, we observed two new races, one with 19 chromosomes (18 autosomes and X, Fig. 1), and the second with 23 (22 autosomes and X, Fig. 2). The first (19 chromosomes) is common throughout Palestine (Judean Hills, the coastal plain, Valley of Esdraelon, Beisan

Figs. 1 and 2. Spermatogonial metaphase of mole-cricket: (1) Palestinian race, 19 chromosomes; (2) Dead Sea race, 23 chromosomes; from preparations fixed in 15 parts picric acid, 5 parts formalin, 1 part 45 per cent acetic acid

Fig. 3. Telophase of meiotic division, an octad lagging in equatorial plane, preparation fixed in Bouin's solution. All sections 10 μ thick, stained in Heidenhain's hæmatoxylin. × 2100

Valley and Galilee), while the second (23 chromosomes) is restricted to a single locality very close to the Dead Sea.

All the elements of the Palestinian race seem to be homologous with those of the central Italian race, except that six small chromosomes occur instead of only two of the same size which are found in the Italian type. In the Dead Sea race there are ten such small chromosomes. In the light of these facts, it was difficult to assume that the direction of evolution was towards reduction, as all the remaining elements appear identical in the three races, a fact which argues against the possibility of translocation. On the other hand, it is also difficult to assume that eight elements would disappear from the chromosome pattern, leading from the Dead Sea type to that of central Italy.

The behaviour of these chromosomes at meiosis was found to be peculiar. In approximately 13 per cent of the observed cases, certain chromosomes lag in the anaphase and telophase. These chromosomes, which can be identified as the small ones, remain as tetrads in the equatorial plane during the anaphase movement of the other dyads. Sometimes plates with octads are seen, linked by means of chiasmata (Fig. 3), a fact which clearly demonstrates the common origin of these small chromosomes. In most of these cases the normal separation of the dyads finally occurs, the dyads joining the nuclei almost at the termination of telophase. But in a considerable percentage of cases a whole tetrad passes to one daughter nucleus, and sometimes even an octad passes to one pole. As a result of this non-disjunction, among second spermatocytes there are cells containing eleven dyads as well as others containing only seven. Since spermatids with varying numbers of chromosomes are formed, one might expect to find mole-crickets with varying numbers of chromosomes, 17, 18, and 21. Examination of 140 mole-crickets from six localities in Palestine has shown that 19 is the only chromosomal number found. Hence it may be concluded that the exceptional gametes or the new types emerging from them are non-viable at some stage in development.

The six small chromosomes show no heteropycnosis at the meiotic prophase, whereas the two small chromosomes in the Italian race exhibit a typical heteropycnosis during meiosis, and become precociously condensed at prophase together with the *X*-element. In the light of this evidence, it is difficult not to conclude that we are dealing with the establishment of permanent from supernumerary chromosomes, in other words, a transition from hetero- to euchromatin. While the transformation of euchromatin to heterochromatin by mutation of active genes to inert ones is more frequently postulated by geneticists, the reversion of this process appears equally plausible.

It may be significant that heterochromatic chromosomes are still present in the Roumanian race and that they behave as typical supernumeraries, that is, their number in the population fluctuates. Thus mole-crickets with 15 or 16 chromosomes are found in addition to the common type with 14 elements[3]. In size and form the additional chromosomes correspond to those described in the Palestinian material. Supernumerary chromosomes of a similar type were also found in *G. africana*[4].

Due to their inertness, supernumerary chromosomes may increase in number in some individuals without causing conspicuous damage. On the other hand, Darlington claimed that in some cases (*Zea Mays*, *Cimex*, etc.) they possess adaptive advantages[9,10]. It may be that a further step involving a certain number of new viable mutations establishes them in certain types.

In this connexion it is interesting to note that the highest chromosome number among the Palestinian mole-crickets (23) is found in the Dead Sea locality, where temperature fluctuation and salinity of soil are extreme. It is an almost inevitable conclusion that the two additional pairs of small chromosomes contain a set of polygenes which enable this race to survive under extreme conditions.

The chromosomes of *G. africana* (23) from the southern Dead Sea fully conform to the description of previous authors[4]. They differ fundamentally from the 23 chromosomes of the Dead Sea race of *G. gryllotalpa*. The 23 chromosomes of *G. africana* can be arranged in a series of fours, which makes it probable that the species is a tetraploid.

Thus the number 24 (in the female) was reached twice by independent methods in the mole-crickets. Whereas in *G. africana* (and probably *G. borealis* and *Scapteriscus*) 24 were obtained by doubling of the original set of 12, in *G. gryllotalpa* a progressive accumulation of small (heterochromatic) chromosomes led to the establishment of a whole series of geographical races and found its climax in the Dead Sea race with the same number, 24. A fuller discussion of this problem and of the origin and behaviour of the small chromosomes will be published elsewhere.

I would like to express my appreciation to Dr. E. Goldschmidt for her aid and encouragement during the progress of this work.

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WRITTEN EXPRESSION IN SCIENCE

A CONFERENCE at the City Boys' School, Leicester, convened and presided over by the headmaster, Mr. R. W. Crammer, was held on March 12 to discuss the problem of the difficulty experienced by science graduates in writing reports and the ways in which the grammar schools could help in overcoming it. Dr. U. R. Evans, reader in the science of metallic corrosion in the University of Cambridge, who had raised the matter in the University Senate House, addressed the conference in a private capacity. There were seventy people present, including the heads of grammar schools in the City and County of Leicester, their English and science masters and mistresses and representatives from Leicester University College, the Domestic Science College and the Women's Training College. The conference was welcomed not only because of the importance of its subject but also because it brought together representatives of the grammar schools and of institutions of higher education for the discussion of a common concern.

In his address, Dr. Evans said that one of the few serious complaints raised to-day against the young scientific graduate refers to his alleged inability to express findings in a written report. Since a report still represents the best means available for a scientific worker to share his knowledge with others, the complaint is a serious one, and suggests that the writing of English does not receive sufficient attention at schools and universities. The dreary character of many papers printed to-day in scientific journals provides further evidence. Complaints are heard of the excessive length of papers submitted for publication, and it is often felt that the mode of presentation is such that a paper fails to hold the attention of those whom it ought to interest; a common fault is the omission to make clear the reasons for selecting the subject of investigation, and to emphasize the significance of the results for those working on other subjects.

The main trouble seems to arise from the fact that often the young scientific worker has no love for writing. Whatever disciplinarians may say, it is doubtful whether anyone makes a real success of a task which gives him no sort of satisfaction. Enthusiastic and hard-working experimenters show an obvious reluctance to produce reports by the appointed day, and require a surprising length of time to produce a very simple memorandum. Even if the results, when ultimately completed, were perfect, the obvious disinclination to use the pen in the communication of ideas reveals an unsatisfactory state of affairs. This aversion to writing is often shown by men who are extremely successful in explaining their ideas by word of mouth.

It is significant that the difficulties affect many who have attained conspicuous success in the examination hall; there they may have been helped, in a manner of which they were scarcely aware, by the fact that they were writing down facts or arguments previously read in a book or heard at a lecture. When suddenly confronted with the task of discovering for themselves a sequence of words to express something hitherto unreduced to verbal form, they experience the same difficulty as is met with by someone who, at the age of twenty, starts to express himself in French or German. In both cases the difficulty would probably be lessened if the first attempts were made at an earlier age.

There are certain grammatical problems met with in reports which, unless solved, can endanger correct understanding. A report usually refers to work accomplished within some definite period, and starts with a statement of the position at the outset, largely based on the work of the previous period; here the correct employment of pluperfects and perfects often presents difficulty. Next will come the programme for the new period, and now the periphrastic constructions needed to express plans made in the relatively distant past for work in the immediate past sometimes involve perplexity—especially since subjunctives and conditionals must often be introduced (for example, where there has been doubt as to how the plans would work out). In the experimental section the problems of expression are mainly technical, but the author's interpretation of his results, involving comparisons with the views of others, may necessitate passage between *oratio recta* and *oratio obliqua*, which some writers find far from easy.

The understanding of a report can be greatly helped by consistent use of the different classes of headings available for division into sections and subsections; conversely, if headings are used indiscriminately, understanding is hindered. Again, punctuation used on any consistent plan will assist comprehension; stops thrown in at random are worse than useless.

It would seem that definite instruction, which need not occupy many hours of school time, is needed in certain subjects—such as punctuation and systematic division into sections and subsections; but that most of the troubles would pass away if the boys received plenty of practice under conditions favourable to the cultivation of a taste for writing. Essay-writing seems to be accepted as the standard method of gaining experience in the arrangement of words, but only a certain type of essay will aid report-writing—namely, that dealing with some subject which the writer has never before seen or heard described in words. A commentary upon a stage-play or film may be a better choice than a discussion of matters described in printed books. The reading of books by great authors is advocated by many. Clearly such reading is worth while for its own sake, but it is doubtful how far literary masterpieces can help the writing of scientific reports; it is scarcely a compliment to their authors to suggest that a style skilfully developed for one purpose should be adopted for another. Nevertheless, the reading of certain authors may serve to enlarge the reader's vocabulary and may show him how the skilful selection of words can introduce delicate shades of meaning into the picture presented. Perhaps others may be found to provide examples of terseness—a matter of practical importance in days when the supply of paper is short and the patience of readers not inexhaustible.

Mr. Crammer, in opening the discussion, pointed out the psychological and sociological difficulties encountered by the grammar schools in the teaching of written expression in English. The grammar schools have in recent years admitted more and more pupils coming from homes in which there is little or no culture or encouragement in the reading of good books or conversation, let alone in writing. The social atmosphere generally has tended to counteract the training in writing given in the schools, a point which was taken up and emphasized by subsequent

speakers, who laid stress on the decline in reading due to the cinema and the radio, as well as on the absence of æsthetic and literary standards in the home.

Others blamed the too early and the excessive specialization in the schools, a fault which the latter referred back to the universities and the increasingly high standard of attainment required by them for the award of scholarships. The 'objective' tests, consisting of one-word answers often used in the examinations for entrance to the grammar schools, were also criticized as not encouraging the teaching and practice of continuous written English in primary schools.

The vital importance of frequent practice in writing was admitted, but the burden of marking it imposed upon the teachers of English would be intolerably heavy if more practice was to be given without an increase in free periods for marking. The position would be better if all teachers, and not only those directly responsible for the teaching of English, regarded themselves as teachers of English as well as of their special subjects, and took the trouble to correct faulty English in all written work. One speaker rightly objected to the division of English into 'Science' English and 'Literary' English; the science graduate's difficulty in written expression is part of the general problem of the teaching of English to all pupils, irrespective of the forms of their later specializations.

After Dr. Evans had replied to the various points raised, Mr. Crammer summed up the discussion. It was clear, he said, (1) that there was general agreement about the necessity of all teachers, and not only the teachers of English, making the writing of English their concern, and (2) that continuous practice in writing is essential and must go on into and throughout the university course as well as throughout school life. It was worth considering whether in science scholarship examinations an essay and a general paper should be made compulsory and should be given considerable weight in deciding the awards. A committee representative of both schools and colleges was formed to investigate the problem further with a view to the formulation of constructive suggestions.

PHYSIOLOGY AND BIOCHEMISTRY OF FATS AND LIPOIDS

A PHYSIOLOGICAL symposium on fats, arranged by Le Centre National de la Recherche Scientifique and supported by the Rockefeller Foundation, was held in Paris during January 5–12. The meetings took place in the Department of General Physiology (Prof. G. Schaeffer) at the Sorbonne. Prof. E. F. Terroine presided.

The conference was opened with a paper by Prof. A. C. Frazer (Great Britain), who described new methods for the study of fat absorption problems, and presented the results of his investigations on the nature of the intestinal emulsifying system and hydrolysis of triglyceride. Prof. P. Desnuelles (France) reported experiments which have confirmed and extended Prof. Frazer's work on the formation of di- and mono-glycerides as end-products of pancreatic lipolysis. Miss E. Le Breton (France) spoke of her demonstration of A- and B-lecithinases and cholesterol esterase in the pancreatic juice. Its possible importance in the fat absorption mechanism was discussed. Prof. F. Verzar (Switzerland) reviewed his work on fat absorption, dealing particularly with his experiments relating the adrenal cortex to fat absorption. Prof. A. C. Frazer followed with a detailed account of the experimental work of his school on the intracellular and distributive phases of fat absorption. Prof. P. E. Verkade (Holland) gave a short paper which illustrated the inadequacy of the alleged solvent action of bile salt solutions for fatty acids. In the subsequent discussion, agreement was reached on the questions of intraluminar emulsification, the probable importance of hydrolysis, phosphorylation and the adrenal cortex in the fat absorption mechanism, and the possible occurrence of particulate absorption of fat. The extent of hydrolysis, amount of material absorbed in particulate form, the function of phosphorylation, and the nature of the influence of the adrenal gland on the fat absorption mechanism, were fully discussed.

Prof. T. Cahn (France) described investigations in dogs designed to determine the effect of muscular exercise, fasting, hyperthermia and pancreatectomy on fat mobilization; and Dr. G. Clément (France) discussed the effects of unilateral denervation on fat mobilization in rats. The relationship between B-lecithinase and cholesterol esterase in the blood, and its influence in the formation of cholesterol esters, was raised by Miss E. Le Breton. Prof. M. Macheboeuf (France) described his work on lipoprotein complexes in blood and gave an account of his extensive investigations into the lipoid content of fractionated plasma proteins, and interesting observations on the replacement of lipoids in lipoprotein by substances of similar molecular structure. Prof. E. Chargaff (United States) gave a survey of the association between lipoids and proteins in biological systems, discussing the possible nature of the forces concerned in the construction of these complexes, with numerous illustrations from his own experiments.

Prof. A. C. Frazer presented an account of some new methods which had been developed for the study of particulate fat in a protein environment. He described his experiments on blood fat and artificial particulate systems. He also reported X-ray diffraction studies on nerve lipoprotein which demonstrated the importance of water in lipoprotein structure, and other useful data. A lengthy discussion on all aspects of blood fat and the methods of study of lipoprotein complexes ensued. Later, Prof. E. Chargaff spoke of his work on blood coagulation, with particular reference to the part played by lipoproteins in these reactions.

Prof. K. Bernhard (Switzerland) described the biological degradation of fatty acids. With extensive references to his own work in this field, he discussed β-, ω- and multiple-oxidation. He suggested that β-oxidation is most likely to occur under natural conditions and that ketones are mainly formed by condensation of the 2-carbon fragments split off by β-oxidation. Prof. P. Verkade discussed the relationship between the ingestion of carbohydrate and triundecylin and the excretion of undecanedioic acid in the urine in healthy human subjects. Administration of carbohydrate causes an increase of dioic aciduria. The possible significance of liver glycogen in these experiments was discussed. Prof. R. H. Barnes (United States) gave a detailed account of recent work on ketogenesis. He described the various steps in the elucidation of this problem by the use of isotope-labelled materials, and put forward a new

hypothesis to explain the anti-ketogenic action of carbohydrates. A session was also devoted to the consideration of lecithin degradation. Dr. M. Kahane (France) described his investigations into the presence of water-soluble choline esters in the blood and tissues, and Prof. J. Roche (France) gave an account of enzymological studies on the hydrolysis of phosphoryl choline and phosphoryl colamine by phosphatases. The structure and hydrolysis of egg lecithin were discussed by Prof. P. Fleury (France).

The nutritional importance of essential unsaturated fatty acids was discussed after a survey of work in this field had been given by Prof. K. Bernhard and Prof. R. H. Barnes. Miss E. Le Breton described experiments on fatty acid dehydrogenases. She described the relationship of certain vitamins and phosphorylation to the activity of these desaturases. Their possible significance in the problem of essential fatty acids was discussed.

In the concluding session, Dr. C. Paquot (France) described his work on the autoxidation of fats, and presented theoretical considerations, both on this question and on the subject of anti-oxidants. Prof. A. Chevallier (France) described apparent relationships between the oxidation and ultra-violet absorption of glycerides, and Prof. P. Dubouloz (France) spoke of his researches on anti-oxidants in relation to vitamin A. He discussed the mechanism of anti-oxidant action and described preliminary experiments on the physiological properties of peroxidized lipids. Prof. R. H. Barnes gave a survey of recent work carried out in the United States on anti-oxidants, and the development of oxidative rancidity in fats. He emphasized the possible importance of rancidity in biological processes.

The official business of the symposium was completed in eight days and was carried through in a most cordial atmosphere. The full proceedings, including summaries of the various discussions, will be published in due course in the *Archives des Sciences Physiologiques*.

METABOLIC ASPECTS OF CONVALESCENCE

THE *Transactions* of two conferences on "Metabolic Aspects of Convalescence" referred to below* make very stimulating reading. Although they are often so specialized that possibly only those who have themselves worked in the particular fields will fully appreciate the significance of some of the questions and answers, yet the general impression left after reading them is that one has made the 'Grand Tour' and become personally acquainted with very interesting people and ideas.

With the exception of the symposium on bone metabolism (*Trans. Fourteenth Meeting*), the reports are more in the nature of short progress notes rather than balanced statements of experiment and interpretation. As one contributor remarks, "The data presented are of a preliminary nature and are offered in the hope that they may stimulate discussion".

Convalescence is concerned with the repair of injured tissues and the restoration of normal functioning so that, in effect, the study of its metabolic aspects is very similar to the general study of growth and development. The vast mass of interrelated factors—which scientific workers are only at the beginning of unravelling—is well illustrated by the wide range of subjects covered at these conferences. The reader finds himself switched from "A Comparison of the Effect of Testosterone Propionate on the Enzyme Content of the Kidney and Liver of Castrated and Normal Rats" to "Metabolic Studies before and after Operation of Chronically Ill Patients fed entirely by Vein", or from "Partition Chromatography on Paper" to "Peritoneal Lavage in Uremia". There were sixty-five reports at the thirteenth meeting and thirty-five at the fourteenth. Between them they seem to cover the ground remarkably thoroughly, and anyone whose work is concerned with any aspect of growth or development is likely to find some point of interest which may well give a new turn to his line of thought. The symposium on bone metabolism (a subject to which a large part of earlier meetings in the series has been devoted) forms a contrast to the rest of the papers. The reports presented are longer and more detailed; there is a clear exposition of contrasting hypotheses and a series of very clear photographs.

These reports pose questions rather than provide answers, but they give the impression of being full of helpful clues and well worth studying.

M. W. GRANT

* Conference on Metabolic Aspects of Convalescence. *Trans.* Thirteenth Meeting, Nawshon Island, Woods Hole, Mass., June 11, 1946. Pp. ii+232. 2 dollars. *Trans.* Fourteenth Meeting, New York, Nov. 7-13, 1946. Pp. ii+190. 2.25 dollars. (Josiah Macy, Jr., Foundation, 46 Park Avenue, New York, 1947.)

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, April 5

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Dr. T. Dalling and Dr. A. W. Stableforth: "Bovine Mastitis".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (joint meeting with the INSTITUTE OF REFRIGERATION, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. G. Eichelberg: "Heat-Pump Problems and Industrial Realizations".

SOCIETY OF ENGINEERS (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. G. Vokes: "Filtration".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. John Lawrence: "The Russian Land and History".

Monday, April 5—Tuesday, April 6

SOCIETY OF CHEMICAL INDUSTRY (in the Mathematics Lecture Theatre, Royal College of Science, Huxley Building, Exhibition Road, London, S.W.7).—Symposium on "Detergents, Wetting and Emulsifying Agents".

Monday, April 5
At 2.15 p.m.—"Synthetic Detergents".

Tuesday, April 6
At 2.15 p.m.—"Wetting Agents and Auxiliary Products".

Tuesday, April 6

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. C. R. Rao: "The Utilization of Multiple Measurements in Problems of Biological Classification".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the GLASGOW SECTION and the GLASGOW AND DISTRICT SECTION of the ROYAL INSTITUTE OF CHEMISTRY, in the Gas Showrooms, Sauchiehall Street, Glasgow), at 2.30 p.m.—Dr. E. C. Bate-Smith: "Refrigeration in Germany"; Mr. H. J. Bunker: "War-time Production of Food Yeast in Germany"; at 7 p.m.—Mr. J. F. Hearne: "German Albumen Substitutes"; Mr. C. B. Brown: "German Synthetic Detergents".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Leon Underwood: "African Art and its Place in Art Tradition".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. R. A. Foulkes: "The Use of Light Alloys in Structures".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. G. Pearce: "Recent Developments in Cast Iron".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, St. Mary's Parsonage, Manchester), at 6.30 p.m.—Miss F. A. Roper: "Places of Interest on the Mediterranean Seaboard".

ROYAL STATISTICAL SOCIETY, TEES-SIDE SUB-GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the William Newton School, Norton, Stockton-on-Tees), at 7 p.m.—Dr. O. L. Davies: "Correlation Problems in the Chemical Industry".

Tuesday, April 6—Friday, April 9

PHYSICAL SOCIETY (at Imperial College, Imperial Institute Road, London, S.W.7).—Thirty-second Exhibition of Scientific Instruments and Apparatus.

Wednesday, April 7

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 1.30 p.m.—Annual General Meeting; at 2.30 p.m.—Dr. H. E. Crossley: "External Deposits on the Heating Surface of Boiler Plant".

ROYAL SOCIETY OF MEDICINE, HISTORY OF MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Symposium on "Conan Doyle and the Doctor and Detective Fiction".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Dr. D. G. Beech: "Statistics Applied to Pottery Problems".

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Annual General Meeting; Mr. G. Foster: "Welding in Railway Workshops".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Thursday, April 8

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 5.15 p.m.—Annual General Meeting: at 5.45 p.m.—Discussion on "The Use of Microphones and Loudspeakers in Buildings and Sound Amplification and Distribution" (to be opened by Mr. Hope Bagenal).

INSTITUTE OF PHYSICS, ELECTRON MICROSCOPY GROUP (in the Anatomy Lecture Theatre, King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. V. E. Cosslett: "Recent Advances in Electron Microscopy in Great Britain".

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the E.M.I. Studios, Ltd., Abbey Road, London, N.W.8), at 6 p.m.—Mr. W. S. Barrell and Dr. G. F. Dutton: "High Fidelity Recording and Reproduction".

CHEMICAL SOCIETY (in the Chemistry Department, The University, Manchester), at 6.30 p.m.—Scientific Papers.

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-WESTERN SECTION (in the Reynolds Hall, College of Technology, Sackville Street, Manchester), at 6.45 p.m.—Mr. H. Stibbe and Mr. K. G. Lockyer: "Factors Governing the Performance of I.F. Amplifiers".

Friday, April 9

BIOCHEMICAL SOCIETY (at University College, Dublin), at 1.30 p.m.—Scientific Papers.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. Bertil Lindblad: "The Dynamics of the Stellar Systems" (George Darwin Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Annual General Meeting.

SHEFFIELD METALLURGICAL ASSOCIATION, METHODS OF ANALYSIS GROUP (at 198 West Street, Sheffield), at 7 p.m.—Mr. B. Bagshawe: "Absorptiometric Determination of Silicon".

SOCIETY OF INSTRUMENT TECHNOLOGY, MIDLAND SECTION (at the Chamber of Commerce Buildings, New Street, Birmingham), at 7 p.m.—Mr. E. E. Hancox: "An Introduction to pH and its Measurement".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Herman F. Mark: "Mechanical Properties of High Polymers as related to their Structure".

Saturday, April 10

BRITISH PSYCHOLOGICAL SOCIETY (at the University, Edmund Street, Birmingham), at 12.15 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MYCOLOGIST IN THE PLANT PATHOLOGY DEPARTMENT—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 10).

LABORATORY STEWARD FOR THE DEPARTMENT OF ZOOLOGY—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (April 10).

LECTURER IN TAXONOMY (Zoology)—The Secretary of University Court, The University, Glasgow (April 14).

VICE-CHANCELLOR, a PROFESSOR OF CHEMISTRY, a PROFESSOR OF MATHEMATICS, a PROFESSOR OF MEDICINE, a PROFESSOR OF SURGERY, a PROFESSOR OF PATHOLOGY, a LECTURESHIP IN PSYCHOLOGY, a LECTURESHIP IN CHEMISTRY, a LECTURESHIP IN ECONOMICS, and a JUNIOR LECTURESHIP (Tutorship) IN ENGLISH, at the University of Hong Kong—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (April 16).

EDUCATIONAL PSYCHOLOGIST in the University Education Centre—The Secretary, The University, Edmund Street, Birmingham 3 (April 17).

ASSISTANT AGRICULTURAL ECONOMIST IN THE DEPARTMENT OF AGRICULTURE—The Registrar, The University, Leeds 2 (April 19).

LECTURERS or ASSISTANT LECTURERS IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Manchester 13 (April 24).

ASSISTANT ARCHÆOLOGY OFFICER—The Deputy Director of Establishment and Finance, Ordnance Survey, Leatherhead Road, Chessington, Surrey (April 26).

ASSISTANT LECTURER IN CHEMISTRY (Inorganic and Physical)—The Registrar, University College, Singleton Park, Swansea (April 28).

LECTURER IN BIOCHEMISTRY, and DEMONSTRATORS (2, one in Biochemistry and one in Physiology)—The Registrar, University College of South Wales, Cathays Park, Cardiff (April 30).

LECTURER IN BOTANY, an ASSISTANT LECTURER IN MATHEMATICS (Pure Mathematics), an ASSISTANT LECTURER IN CHEMISTRY (preferably with interests in Inorganic and Physical Chemistry), and an ASSISTANT LECTURER IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 3).

HEADSHIPS OF THE DEPARTMENTS OF PHYSICS, MATHEMATICS, CHEMISTRY at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (May 10).

PRINCIPAL OF THE CANBERRA UNIVERSITY COLLEGE—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (May 15).

ASSISTANT CHEMISTS (Honours degree majoring in chemistry), an ASSISTANT CHEMIST (Honours degree specializing in colloidal chemistry for research on rotary drilling fluid controls), ASSISTANT PHYSICISTS (1st class Honours degree in physics with mathematics and some chemistry), a CHEMICAL ENGINEER, and "MUD" (Trainee) ENGINEERS (Graduate chemists with working knowledge of colloidal chemistry), to undertake research duties with a large industrial organization in the Middle East—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.263/47A (May 20).

JUNIOR LECTURER IN APPLIED MATHEMATICS—The Secretary of Faculties, University Registry, Oxford (June 2).

MACLEOD-SMITH CHAIR OF BIOLOGICAL CHEMISTRY—The Secretary, The University, Aberdeen (June 15).

PRINCIPAL OF AUCKLAND UNIVERSITY COLLEGE, Auckland—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 30).

CHAIR OF GEOLOGY, and the CHAIR OF ZOOLOGY, at the University, Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (Sydney, June 30).

LECTURER IN BACTERIOLOGY AND PARASITOLOGY—The Principal, South African Native College, Fort Hare, C.P., South Africa (applications to be made by air mail).

SCIENTIFIC OFFICER, and ASSISTANT EXPERIMENTAL OFFICERS (2), for research on the antibiotic substances of streptococci—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

ASSISTANT ENGINEER (Grade BI) for Filtration Research—The Clerk to the Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, quoting Ref. N.

CHEMIST (Organic) FOR THE DEPARTMENT OF CHEMICAL PATHOLOGY—Prof. N. F. Maclagan, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

SCIENTIFIC OFFICER to assist in research problems connected with steel castings—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

TECHNICAL ENGINEER IN THE DEPARTMENT OF ATOMIC ENERGY (Production)—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

LABORATORY ASSISTANT (Grade I) FOR THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

CHIEF CHEMIST to take charge of the work of the Chemical Department at laboratories at Elmstead Woods—The Director, British Scientific Instrument Research Association, 26 Russell Square, London, W.C.1.

DEMONSTRATOR IN THE DEPARTMENT OF PHYSICS—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

JUNIOR GRADUATE CHEMIST in the photographic and chemical section of the Optical Department—The Superintendent of Laboratories, British Scientific Instrument Research Association, 'Sira', Southill, Elmstead Woods, Chislehurst, Kent.

GRADUATE B.Sc. IN CHEMISTRY or BIOCHEMISTRY, with experience of hospital laboratory work—The Medical Officer of Health, Johnston Terrace, Edinburgh 1.

SENIOR GEOLOGIST FOR MINES DEPARTMENT, Adelaide—The Agent-General for South Australia, South Australia House, Marble Arch, London, W.1.